CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL VALLEY REGION

Amendments to the Water Quality Control Plan For the Sacramento River and San Joaquin River Basins

For

The Control of Diazinon and Chlorpyrifos Runoff into the Sacramento-San Joaquin Delta

Appendix A

Waterways of the Sacramento-San Joaquin Delta

January, 2006 Peer Review Draft

This Appendix lists the Sacramento-San Joaquin Delta Waterways[i] (Delta Waterways) to which the site-specific water quality objectives, implementation and monitoring provisions apply. The main body of the Basin Plan refers to this Appendix, where applicable. Each Delta Waterway is included in the list because it is a distinct, readily identifiable waterbody within the boundaries of the "Legal" Delta that is hydrologically connected by surface water flows (not including pumping) to the Sacramento and/or San Joaquin rivers. Figure A-1 *(To Be Added)* shows the locations of the Delta Waterways.

1. 45 Canal
2. Alamo Creek
3. Babel Slough
4. Barker Slough
5. Bear Creek
6. Bear Slough
7. Beaver Slough
8. Big Break
9. Bishop Cut
10. Black Slough
11. Broad Slough
12. Brushy Creek
13. Burns Cutoff
14. Cabin Slough
15. Cache Slough
16. Calaveras River
17. Calhoun Cut
18. California Aqueduct
19. Clifton Court Forebay
20. Columbia Cut
21. Connection Slough
22. Corral Hollow Creek
23. Cosumnes River
24. Crocker Cut
25. Dead Dog Slough
26. Dead Horse Cut
27. Deer Creek
28. Delta Cross Channel
29. Disappointment Slough
30. Discovery Bay
31. Donlon Island
32. Doughty Cut
33. Dry Creek (Marsh Creek tributary)
34. Dry Creek (Mokelumne River tributary)
35. Duck Slough
36. Dutch Slough
37. Elk Slough
38. Elkhorn Slough
39. Emerson Slough
40. Empire Cut
41. Fabian and Bell Canal
42. False River
43. Fisherman's Cut
44. Fivemile creek
45. Fivemile Slough
46. Fourteenmile Slough
47. Franks Tract
48. French Camp Slough
49. Gallagher Slough
50. Georgiana Slough
51. Grant Line Canal
52. Grizzly Slough
53. Haas Slough
54. Hastings Cut
55. Hog Slough
56. Holland Cut
57. Honker Cut
58. Horseshoe Bend
59. Indian Slough
60. Italian Slough
61. Jackson Slough
62. Kellogg Creek
63. Lateral 4 West
64. Lateral 5 East
65. Lateral 5 West
66. Latham Slough
67. Liberty Cut
68. Lindsey Slough
69. Little Connection Slough
70. Little Franks Tract
71. Little Mandeville Cut
72. Little Potato Slough
73. Little Venice Island
74. Livermore Yacht Club
75. Lookout Slough
76. Lost Slough

77. Lower Main Canal
78. Main Canal
79. Marsh Creek
80. Mayberry Cut
81. Mayberry Slough
82. Middle River
83. Middle Slough
84. Mildred Island
85. Miner Slough
86. Mokelumne River
87. Mormon Slough
88. Morrison Creek
89. Mosher Slough
90. Mountain House Creek
91. North Canal
92. North Fork Mokelumne River
93. North Victoria Canal
94. Old River
95. Paradise Cut
96. Piper Slough
97. Pixley Slough
98. Potato Slough
99. Prospect Slough
100. Putah Sinks
101. Red Bridge Slough
102. Rhode Island
103. Rock Slough
104. Sacramento Deep Water Channel
105. Sacramento River
106. Salmon Slough
107. San Joaquin River
108. Sand Creek
109. Sand Mound Slough
110. Santa Fe Cut
111. Sevenmile Slough
112. Shag Slough
113. Sheep Slough
114. Sherman Lake
115. Short Slough
116. Singapore Cut
117. Smith Canal
118. Snodgrass Slough
119. South Fork Putah Creek
120. South Fork Mokelumne River
121. Stanislaus River
122. Steamboat Slough
123. Stockton Deep Water Channel
124. Stone Lakes
125. Sugar Cut
126. Sutter Slough
127. Sweany Creek
128. Sycamore Slough
129. Taylor Slough
(Elkhorn Slough tributary)
130. Taylor Slough
(near Franks Tract)
131. Telephone Cut
132. The Big Ditch
133. The Meadows Slough
134. Three River Reach
135. Threemile Slough
136. Toe Drain
137. Tom Paine Slough
138. Tomato Slough
139. Trapper Slough
140. Turner Cut
141. Ulatis Creek
142. Upland Canal
143. Upper Main Canal
144. Victoria Canal
145. Walker Slough
146. Walthall Slough
147. Washington Cut
148. Werner Dredger Cut
149. West Canal
150. Whiskey Slough
151. White Slough
152. Winchester Lake
153. Woodward Canal
154. Wright Cut
155. Yolo Bypass[ii]
156. Yosemite Lake

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[i] The Delta Waterways include only those reaches that are located within the "Legal" Delta, as defined in Section 12220 of the California Water Code.

[ii] When flooded, the entire Yolo Bypass is a Delta Waterway. When the Yolo Bypass is not flooded, the Toe Drain is the only Delta Waterway within the Yolo Bypass.

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Appendix B

Summary of Water Quality Monitoring Programs, Studies, and Databases Used as Sources of Delta and Delta Tributary Diazinon and Chlorpyrifos Concentration Data

January, 2006 Peer Review Draft

INTRODUCTION

This appendix summarizes the sources of water quality data used in this report. The table summarizes the data sources, and is followed by the list of full citations.

Reference Citation	Agency	Title	Monitoring Time Period	Sample Frequency and Timing	Monitoring Sites in the Delta Watershed
MacCoy et al., 1995	USGS	Dissolved Pesticide Data for the San Joaquin River at Vernalis and the Sacramento River at Sacramento, California, 1991-1994. USGS Open File Report 95-110	Jan 1991 – April 1994	Samples collected approximately 3 times per week, year round	San Joaquin River at Vernalis, Sacramento River at Sacramento
Kuivila and Foe, 1995	USGS, CRWQCB-CVR	Concentrations, Transport and Biological Effects of Dormant Spray Pesticides in the San Francisco Estuary, California	January – February 1993	Samples collected daily (twice a day at Vernalis)	Sacramento River at Sacramento, Sacramento River at Rio Vista, Chipps Island (Suisun Bay), Martinez (Suisun Bay), San Joaquin River at Vernalis, San Joaquin River at Stockton, Old River, Middle River, Grant Line Canal
Bailey et al., 2000	UC Davis, CRWQCB-CVR	Diazinon and Chlorpyrifos in Urban Waterways in Northern California, USA	1994 – 1995	Most samples collected Oct – May, generally associated with runoff events, some dry-weather samples. Samples collected during rising limb of hydrograph	Mosher Slough, Five Mile Slough, Mormon Slough, Smith Canal, Walker Slough, Calaveras River

Reference Citation	Agency	Title	Monitoring Time Period	Sample Frequency and Timing	Monitoring Sites in the Delta Watershed
Domagalski, 2000	USGS	Pesticides in Surface Water Measured at Select Sites in the Sacramento River Basin, California, 1996-1998 (Water-Resources Investigations Report 00-4203)	Nov 1996 to April 1998	Monthly and bi-monthly	Sacramento River at Freeport, Yolo Bypass at Hwy 80, Colusa Basin Drain Near Knights Landing
Foe and Sheipline, 1993	CRWQCB-CVR	Pesticides in Surface Water From Application on Orchards and Alfalfa During the Winter and Spring of 1991-1992	Orchard: Jan – Feb 1992 Alfalfa: Mar – April 1992	Orchard: weekly Alfalfa: weekly (water samples that tested toxic were submitted for pesticide analysis; five non-toxic water samples were also submitted)	Orchard: Mokelumne R at New Hope Rd, French Camp Sl at Manthey Rd, Old R at Cohen Rd, San Joaquin R at Bowman Rd, Lone Tree Ck at Austin Rd, Marsh Ck at Cypresss Rd, Alfalfa: Old R at Tracy Rd, Paradise Cut at Paradise Rd, Bishop Cut at 8 Mile Rd, Ulatis Ck at Salem Rd, Bishop Tract Main Drain
Reyes et al., 2000	UC Davis, CRWQCB-CVR	Orchard In-Season Spray Toxicity Monitoring Results, 1997	April 1997 – September 1997	biweekly	Calaveras River at Solari Ranch Rd, French Camp Slough at El Dorado St.

Reference Citation	Agency	Title	Monitoring Time Period	Sample Frequency and Timing	Monitoring Sites in the Delta Watershed
Ross et al., 1996 ; Ross et al., 1999	DPR	Distribution and mass loading of insecticides in the San Joaquin River, California: spring 1991 and 1992. DPR report EH 99-01 Distribution and mass loading of insecticides in the San Joaquin River, California: winter 1991-92 and 1992-93. DPR report EH 96-06 Four memoranda by L. Ross (DPR) Six memoranda by R. Fujumura (DFG)	March 1991 – February 1993		San Joaquin River nr Vernalis
Bennett, et al., 1998	DPR	Occurrence of aquatic toxicity and dormant-spray pesticide detections in the San Joaquin River watershed, winter 1996-97. (SWDB study 32)	Winter 1996-1997	Daily during storm events	San Joaquin River nr Vernalis
Foe, 1995	CRWQCB-CVR	Insecticide concentrations and invertebrate bioassay mortality in agricultural return water from the San Joaquin basin	Feb 1991 – June 1992		San Joaquin River nr Vernalis

Reference Citation	Agency	Title	Monitoring Time Period	Sample Frequency and Timing	Monitoring Sites in the Delta Watershed
Ganapathy, 1999a	DPR	Preliminary results of acute and chronic toxicity testing of surface water monitored in San Joaquin River watershed, winter 1997-98	December 1997 – March 1998		San Joaquin River nr Vernalis
Lee and Jones-Lee, 1999	DeltaKeeper, CRWQCB-CVR, City of Stockton, UC Davis Aquatic Toxicology Laboratory	Conclusions from review of the City of Stockton urban stormwater runoff aquatic life toxicity studies conducted by the Central Valley Regional Water Quality Control Board, DeltaKeeper, City of Stockton, and the University of California, Davis Aquatic Toxicology Laboratory between 1994 and 1999	1994 – 1999		Calaveras River at Pacific Avenue, Duck Creek at El Dorado Street, Five Mile Slough at Plymouth, Mosher Slough at Mariners Drive, Smith Canal at Pershing, Walker Slough at Manthey
City of Stockton, 1997	City of Stockton, Department of Municipal Utilities	City of Stockton: 1995-96 National Pollution Discharge Elimination System Storm Water Monitoring Program Data.	1995-1996		Calaveras River at Sutter Street, Calaveras River at West Lane, Duck Creek at West Pacific Industrial Park, Mosher Slough at Kelley Drive, Mosher Slough at Thorton Road

Reference Citation	Agency	Title	Monitoring Time Period	Sample Frequency and Timing	Monitoring Sites in the Delta Watershed
Ganapathy, 1999b	DPR	Preliminary results of acute and chronic toxicity testing of surface water monitored in the San Joaquin River watershed, winter 1998-99	Dec 1998 – Mar 1999		San Joaquin River nr Vernalis
Jones, 1999	DPR	Protocol for monitoring acute and chronic toxicity in the San Joaquin River watershed, winter 1999-2000. Document Review and Approval, Environmental Monitoring and Pest Management, Department of Pesticide Regulation, Sacramento, California	Dec 1999 – Mar 2000		San Joaquin River nr Vernalis
Larry Walker Associates, 2005	Maintained by Larry Walker Associates for Sacramento Regional County Sanitation District	Sacramento Coordinated Monitoring Program (CMP) Database	Jan 1997 - Feb 2005		Sacramento River at Freeport, Sacramento River at Mile 44

Reference Citation	Agency	Title	Monitoring Time Period	Sample Frequency and Timing	Monitoring Sites in the Delta Watershed
Larry Walker Associates, 2002	Sacramento River Watershed Program	Sacramento River Watershed Program Water Quality Database	Feb 2000, May 2000		Sacramento River at Freeport, Cache Slough nr Ryer Island
Deanovic et al, 1996	CRWQCB-CVR, UC Davis Aquatic Toxicology Laboratory, SWRCB	Sacramento-San Joaquin Delta Bioassay Monitoring Report 1993-1994	May 1993 – May 1994	Samples were collected monthly, during low tide. When pesticides were identified in the TIE process as primary toxicants, their concentrations were then determined	Sacramento River at Greene's Landing, , San Joaquin River at Vernalis, Pierson Tract Main Drain, Ulatis Creek, Prospect Slough, Paradise Cut, Duck Slough, French Camp Slough, Lake McLeod (downtown Stockton), Old River at Hwy 4
Deanovic et al., 1998	CRWQCB-CVR, UC Davis Aquatic Toxicology Laboratory, SWRCB	Sacramento-San Joaquin Delta Bioassay Monitoring Report: 1994-95	June 1994 – July 1995	Samples collected once per sampling event; Pesticide analysis only when a sample was determined to be toxic	Sacramento River at Greene's Landing, San Joaquin R at Vernalis, Ryer Island, Middle Roberts Tract, Duck Slough, French Camp Slough, Ulatis Creek, Haas Slough, Mosher Slough, Paradise Cut, Sycamore Slough, Old River at Tracy Blvd

Reference Citation	Agency	Title	Monitoring Time Period	Sample Frequency and Timing	Monitoring Sites in the Delta Watershed
Lu, 2004	CRWQCB-CVR	Sacramento and San Joaquin Delta Pesticides Monitoring Report 2002 and 2003	2002 - 2003	monthly	Mokelumne River at New Hope Rd, Mosher Slough at Mariners Dr, Fivemile Slough at Plymouth, Calaveras River at Ijams Rd, Mid-Roberts Is Drain at Woodbro, French Camp Slough at Carolyn Weston Blvd, Paradise Cut at Paradise Rd, Old R at Tracy Rd, Marsh Creek at Cypress Rd, Ulatis Creek at Brown Rd, Duck Slough nr Five Point, Steamboat Slough at Hogback Park, Cache Slough at Real McCoy, Sacramento River at Rio Vista
Menconi, 2001	CRWQCB-CVR	Unpublished data from Delta Waterways Study in 2001.	April – May 2001		Georgiana Sl at the south end of Tyler Island, Steamboat Slough at Hogback Park, Mosher Slough at Mariners Dr, Fivemile Slough at Plymouth, Calaveras River at Ijams Rd, McCleod Lake in Stockton, Walker Slough west of Manthey Dr, Mid-Roberts Island Drain at Woodbro, Paradise Cut at Paradise Rd, Whiskey Slough at Whiskey Slough Harbor, Tom Paine Slough south of Paradise Cut, Sutter Slough 1.5 mi. south of Sutter Island Cross Road

Reference Citation	Agency	Title	Monitoring Time Period	Sample Frequency and Timing	Monitoring Sites in the Delta Watershed
SFEI, 2005	San Francisco Estuary Institute Regional Monitoring Program	San Francisco Estuary Institute Regional Monitoring Program, Dissolved Pesticide Concentrations in Water Samples	1994 – 1997		Sacramento River near Sherman Island, San Joaquin River near Antioch
Kratzer, 1998	USGS	Pesticides in storm runoff from agricultural and urban areas in the Tuolumne River basin in the vicinity of Modesto, California	1994-1995	Daily during storm events	San Joaquin River at Vernalis
City and County of Sacramento, 1997	City and County of Sacramento	Sacramento stormwater NPDES permit monitoring program, 1990, 1991, 1992, 1994-95, and 1995-1996.	1991-1992, 1994-1996		Sacramento River at Freeport where stormwater pumping facility Sump 3 discharges, Sacramento River at Miller Park
Bacey, 2002	DPR	Preliminary Results of Pesticide Residue Analysis Acute and Chronic Toxicity Testing of Surface Water Monitored in the San Joaquin River Watershed, Winter 2000-2001.	Dec 2000 - Mar 2001		San Joaquin River at Vernalis
Starner, 2002	DPR	Monitoring Surface Waters of the San Joaquin River Basin for Selected Summer-Use Pesticides.	July – September 2002		San Joaquin River at Vernalis

Reference Citation	Agency	Title	Monitoring Time Period	Sample Frequency and Timing	Monitoring Sites in the Delta Watershed
Kratzer, 1997	USGS	Transport of Diazinon in San Joaquin River Basin, California. U.S. Geological Survey Open File Report 97-411.	Jan – Feb 1994	Samples collected throughout the storm hydrograph	San Joaquin River at Vernalis
Holmes, et al. 2000	CRWQCB-CVR, UC Davis Aquatic Toxicology Laboratory	Monitoring of Diazinon Concentrations and Loadings, and Identification of Geographic Origins Consequent to Stormwater Runoff From Orchards in the Sacramento River Watershed, U.S.A.	Jan – March 1994	Daily following storm events, with some interval sampling	Sacramento River at Tower Bridge, Colusa Basin Drain
Dileanis et al., 2002.	USGS	Occurrence and Transport of Diazinon in the Sacramento River, California, and Selected Tributaries During Three Winter Storms, January – February 2000. USGS Water-Resources Investigations Report 02-4101	Jan – Feb 2000	Daily samples following Jan-Feb Storm Events	Sacramento River at Tower Bridge, Colusa Basin Drain at Road 99E near Knights Landing

Reference Citation	Agency	Title	Monitoring Time Period	Sample Frequency and Timing	Monitoring Sites in the Delta Watershed
Dileanis et al., 2003	USGS and DPR	Occurrence and Transport of Diazinon in the Sacramento River and Selected Tributaries, California, during Two Winter Storms, January-February 2001.	Jan-Feb 2001	Daily samples following Jan-Feb Storm Events	Sacramento River at Sacramento
Dileanis, 2003	USGS and DPR	Data from 2002 Dormant Spray Season Water Quality Monitoring Performed by U.S. Geological Survey and CVRWQCB.	Jan-Feb 2002	Daily samples following January and February Storm Events	Sacramento River at Sacramento
Dileanis, 2003	USGS	Data from 2003 dormant spray season water quality monitoring performed by the US Geological Survey.	Jan-Feb 2003	Daily samples following January and February Storm Events	Sacramento River at Sacramento

Reference Citation	Agency	Title	Monitoring Time Period	Sample Frequency and Timing	Monitoring Sites in the Delta Watershed
San Joaquin County and Delta Water Quality Coalition, 2005	San Joaquin County and Delta Water Quality Coalition	San Joaquin County and Delta Water Quality Coalition data collected for the Conditional Irrigated Lands Waiver Program. Data. Submitted in Annual Monitoring Report (May-Sep) and Storm data (Nov-April) still in draft form.	2004-2005	Interval Sampling	Calaveras River at Bellota Intake, Delta Drain- Terminous Tract off Glascock Rd, Duck Creek at Hwy 4, French Camp Slough at Airport Way, Grant Line Canal at Arnando, Grant Line Canal near Calpack Rd, Kellogg Creek at Hwy 4, Littlejohns Creek at Jacktone Rd, Lone Tree Creek at Jacktone Rd, Marsh Creek at Balfour Ave, Mokelumne River at Bruella Rd, Potato Slough at Hwy 12, Terminous Tract Drain at Hwy 12

Reference Citation	Agency	Title	Monitoring Time Period	Sample Frequency and Timing	Monitoring Sites in the Delta Watershed
DWR, 2005	DWR	Bay Delta and Tributaries Project	May 1998 - May 2002	various	Barker Slough at Cook Road, Barker Slough at North Bay Pumping Plant, Calhoun Cut at Hwy 113, Colusa Basin Drain above Knights Landing, Lindsey Slough at Hastings Island Bridge, Shag Slough at Liberty Island Bridge, San Joaquin River at Vernalis, Big Break near Oakley, Frank's Tract near Russo's Landing, Old River at Rancho Del Rio, Sacramento River at Greene's Landing, Sacramento River above Point Sacramento, Sherman Lake near Antioch, San Joaquin River at Antioch, San Joaquin River at Mossdale Bridge, San Joaquin River at Buckley Cove
USGS NWIS, 2005	USGS	USGS NWIS web water quality data. http://waterdata.usgs.gov/nwis/	Apr 1992 - Sept 2001	various	French Camp Slough at Airport Way, Middle River at Middle River, Sacramento River at Freeport, Sacramento River at Rio Vista, Sacramento River at Tower Bridge, San Joaquin River at Vernalis, Yolo Bypass at I-80 nr West Sacramento

Reference Citation	Agency	Title	Monitoring Time Period	Sample Frequency and Timing	Monitoring Sites in the Delta Watershed
Kuivila and Moon, 2004	USGS	Kuivila, K.M. and G.E. Moon. 2004. Potential Exposure of Larval and Juvenile Delta Smelt to Dissolved Pesticides in the Sacramento-San Joaquin Delta, California.	Apr 1998 – July 2000	Interval Sampling	Barker Slough, Cache Slough at Hastings, Frank's Tract, Indian Slough at Discovery Bay Marina Boat Ramp near Discovery Bay, Lindsey Slough, Middle River at Empire Cut, along east arm of River, Middle River at Middle River, Old River at Mouth of Holland Cut, Old River at Santa Fe Cut, Old River Northwest of Coney Island, Old River, western arm at Railroad Bridge, Sacramento River at Tower Bridge, San Joaquin River at Jersey Point, San Joaquin River at mouth of Calaveras River at Light 41, San Joaquin River at Stockton, San Joaquin River at Vernalis, San Joaquin River between Hog Slough and Turner Cut At Light 21
Calanchini et al., 2005a	UC Davis	In Progress. Data from 2004 Delta Monitoring	2004	Interval Sampling	

Reference Citation	Agency	Title	Monitoring Time Period	Sample Frequency and Timing	Monitoring Sites in the Delta Watershed
Calanchini et. al., 2005b	UC Davis	In Progress. Results of the 2005 TMDL monitoring for Diazinon and Chlorpyrifos in California's Central Valley Waterways January - February 2005.	Jan-Feb 2005	Daily following storm events	Sacramento River at Sacramento San Joaquin River at Vernalis

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Appendix C

Comparison of Existing Concentrations to the Proposed Loading Capacity

January, 2006 Peer Review Draft

INTRODUCTION

Appendix C compares measured diazinon and chlorpyrifos concentrations to the proposed Loading Capacity (LC) for the Delta Waterways. The number of samples, number exceedances of the proposed Loading Capacity, and the average and maximum reductions that would be needed to meet the proposed loading capacity during exceedances are summarized for each water year in which data are available at each location. The data sources are listed in Appendix B. As discussed in the main body of the report the Loading Capacity is determined using Equation 1:

$$\frac{C_1}{O_1} + \frac{C_2}{O_2} = S\ ,\ S \leq 1 \qquad \text{[Equation 1]}$$

Where:

C = The concentration of each pesticide.

O = The proposed acute toxicity water quality objective for diazinon to protect invertebrates (0.16 µg/L) and the proposed acute water quality objective for chlorpyrifos (0.025 µg/L).

S = The sum. A sum greater than one (1.0) indicates an exceedance of the Loading Capacity.

For each exceedance of the Loading Capacity, the percent reduction that would be necessary to meet the Loading Capacity was calculated using the following formula:

$$\text{Percent reduction needed to meet the Loading Capacity} = \frac{S - 1}{S} * 100$$

Where:
S = The sum from Equation 1.

For the observed exceedances at each location, the average (mean) and maximum percent reduction needed to meet the Loading Capacity were determined.

Table C-1. Comparison of Concentration data with the proposed Loading Capacity

Location	Water Year[i]	# of samples	# of samples > LC	% of samples > LC	avg % reduction needed to meet LC during exceedances	max % reduction needed to meet LC
Barker Slough	1996	2	0	0%	-	-
	1997	4	0	0%	-	-
	1998	5	0	0%	-	-
Bishop Cut	1992	1	0	0%	-	-
Bishop Tract	1992	2	0	0%	-	-
Cache Slough at Hastings	1998	6	0	0%	-	-
	2000	7	0	0%	-	-
Cache Slough nr Outlet	2000	1	0	0%	-	-
	2002	3	0	0%	-	-
	2003	27	1	4%	31%	31%
	2004	18	0	0%	-	-
Calaveras River at Bellota Intake	2004	2	0	0%	-	-
Calaveras River ds Stockton Diverting Channel	1996	6	4	67%	79%	93%
	1997	1	0	0%	-	-
	2001	5	2	40%	32%	51%
	2002	4	0	0%	-	-
	2003	12	3	25%	38%	63%
	2004	15	6	40%	44%	83%
Calhoun Cut	1996	1	0	0%	-	-
	1997	5	0	0%	-	-
Colusa Basin Drain nr Knights Landing	1999	5	0	0%	-	-
	2000	10	0	0%	-	-

Table C-1. Comparison of Concentration data with the proposed Loading Capacity

Location	Water Year[i]	# of samples	# of samples > LC	% of samples > LC	avg % reduction needed to meet LC during exceedances	max % reduction needed to meet LC
	2001	8	1	13%	96%	96%
	2002	4	0	0%	-	-
	2003	18	0	0%	-	-
	2004	18	3	17%	9%	11%
	2005	11	0	0%	-	-
Delta Drain on Terminous Tract	2005	4	0	0%	-	-
Delta Outflow at Chipps Island	1993	1	0	0%	-	-
Duck Creek	1996	3	2	67%	86%	94%
	1997	1	1	100%	57%	57%
	2004	2	0	0%	-	-
Duck Slough	1993	1	0	0%	-	-
	1994	1	0	0%	-	-
	1995	2	2	100%	96%	96%
	2002	4	0	0%	-	-
	2003	23	0	0%	-	-
	2004	16	10	63%	71%	95%
Five-Mile Slough	1996	2	2	100%	78%	80%
	1997	1	1	100%	78%	78%
	1998	2	1	50%	84%	84%
	2001	4	0	0%	-	-
	2002	4	0	0%	-	-
	2003	25	5	20%	34%	71%
	2004	19	8	42%	46%	73%
French Camp Slough	1992	4	3	75%	62%	86%
	1994	5	4	80%	75%	95%
	1995	1	0	0%	-	-
	1996	1	1	100%	21%	21%
	1999	1	1	100%	31%	31%
	2002	4	0	0%	-	-
	2003	21	1	5%	62%	62%
	2004	19	7	37%	55%	89%
	2005	2	0	0%	-	-
Georgiana Slough	2001	6	0	0%	-	-
Grant Line Canal	1993	13	5	38%	34%	77%

Table C-1. Comparison of Concentration data with the proposed Loading Capacity

Location	Water Year[i]	# of samples	# of samples > LC	% of samples > LC	avg % reduction needed to meet LC during exceedances	max % reduction needed to meet LC
	2003	4	0	0%	-	-
	2005	4	1	25%	67%	67%
Haas Slough	1995	1	0	0%	-	-
Indian Slough	2000	7	0	0%	-	-
Kellogg Creek	2005	1	1	100%	86%	86%
Lindsey Slough	1996	1	0	0%	-	-
	1997	4	0	0%	-	-
	1998	12	0	0%	-	-
	1999	10	0	0%	-	-
Littlejohns Creek	2004	2	0	0%	-	-
	2005	2	0	0%	-	-
Lone Tree Creek	1992	5	4	80%	78%	94%
	2004	2	0	0%	-	-
	2005	2	1	50%	10%	10%
Marsh Creek	1992	1	1	100%	43%	43%
	2002	4	0	0%	-	-
	2003	29	3	10%	31%	63%
	2004	16	0	0%	-	-
	2005	2	0	0%	-	-
McLeod Lake	2001	4	0	0%	-	-
Middle River at Tracy Blvd	2003	4	0	0%	-	-
Middle River near Middle River, CA	1993	47	0	0%	-	-
	1998	6	0	0%	-	-
	1999	5	0	0%	-	-
	2000	7	0	0%	-	-
Middle Roberts Island Drain	1995	2	1	50%	43%	43%
	2001	5	0	0%	-	-
	2002	4	0	0%	-	-
	2003	21	6	29%	52%	93%
	2004	13	4	31%	57%	90%
Mokelumne River near Delta Boundary	1992	2	0	0%	-	-

Table C-1. Comparison of Concentration data with the proposed Loading Capacity

Location	Water Year[i]	# of samples	# of samples > LC	% of samples > LC	avg % reduction needed to meet LC during exceedances	max % reduction needed to meet LC
Mokelumne River near Delta Boundary	2002	4	0	0%	-	-
Mokelumne River near Delta Boundary	2003	21	1	5%	29%	29%
Mokelumne River near Delta Boundary	2004	15	1	7%	52%	52%
Mokelumne River u/s of Lodi	2004	2	0	0%	-	-
Mokelumne River u/s of Lodi	2005	2	0	0%	-	-
Mosher Slough	1995	2	2	100%	86%	86%
	1996	6	6	100%	87%	94%
	1997	1	1	100%	86%	86%
	1998	2	2	100%	87%	87%
	2001	5	0	0%	-	-
	2002	4	0	0%	-	-
	2003	24	9	38%	33%	59%
	2004	19	11	58%	55%	86%
Old River at Highway 4	1993	1	0	0%	-	-
	1994	1	0	0%	-	-
Old River at Tracy Rd	1992	1	0	0%	-	-
	1994	1	0	0%	-	-
	2002	4	0	0%	-	-
	2003	17	1	6%	32%	32%
	2004	10	0	0%	-	-
Old River Northwest of Coney Island	1999	5	0	0%	-	-
Old River nr Bacon Island	1993	19	0	0%	-	-
	1998	6	0	0%	-	-
	1999	10	0	0%	-	-
Old River off Cohen Road	1992	2	1	50%	55%	55%
Paradise Cut	1994	7	3	43%	84%	96%
	1995	3	3	100%	81%	85%
	2001	5	0	0%	-	-
	2002	4	0	0%	-	-
	2003	17	0	0%	-	-
Pierson District Main Drain	1994	1	0	0%	-	-
Potato Slough	2004	2	0	0%	-	-
	2005	2	0	0%	-	-
Prospect Slough	1993	1	0	0%	-	-

Table C-1. Comparison of Concentration data with the proposed Loading Capacity

Location	Water Year[i]	# of samples	# of samples > LC	% of samples > LC	avg % reduction needed to meet LC during exceedances	max % reduction needed to meet LC
Ryer Island Drain	1995	2	0	0%	-	-
Sacramento River at Freeport	1997	15	0	0%	-	-
	1998	11	0	0%	-	-
	1999	16	0	0%	-	-
	2000	17	0	0%	-	-
	2001	22	0	0%	-	-
	2002	3	0	0%	-	-
	2003	4	0	0%	-	-
	2004	5	0	0%	-	-
	2005	5	0	0%	-	-
Sacramento River at Greene's Landing	1994	1	1	100%	43%	43%
Sacramento River at Mile 44	1999	4	0	0%	-	-
	2000	2	0	0%	-	-
	2001	9	0	0%	-	-
	2002	3	0	0%	-	-
	2004	5	1	20%	60%	60%
	2005	3	0	0%	-	-
Sacramento River at Rio Vista	1993	39	4	10%	29%	48%
	2002	3	0	0%	-	-
	2003	28	2	7%	31%	31%
	2004	18	0	0%	-	-
Sacramento River at Sacramento	1992	141	0	0%	-	-
	1993	176	5	3%	26%	48%
	1994	98	3	3%	27%	37%
	1995	3	0	0%	-	-
	2000	30	0	0%	-	-
	2001	12	0	0%	-	-
	2003	27	0	0%	-	-
	2004	19	1	5%	31%	31%
	2005	15	0	0%	-	-
Sacramento River near Sherman Island	1994	2	0	0%	-	-
	1995	3	0	0%	-	-
	1996	2	0	0%	-	-
	1997	3	0	0%	-	-
	1998	2	0	0%	-	-
	1999	3	0	0%	-	-
Shag Slough	1997	1	0	0%	-	-
San Joaquin River at Antioch	1994	2	0	0%	-	-
	1995	2	0	0%	-	-
	1996	1	0	0%	-	-

Table C-1. Comparison of Concentration data with the proposed Loading Capacity

Location	Water Year[i]	# of samples	# of samples > LC	% of samples > LC	avg % reduction needed to meet LC during exceedances	max % reduction needed to meet LC
	1997	3	0	0%	-	-
	1998	1	0	0%	-	-
	1999	2	0	0%	-	-
	2000	1	0	0%	-	-
	2003	4	0	0%	-	-
San Joaquin River at Bowman Rd	1992	3	2	67%	66%	72%
San Joaquin River at Jersey Point	1999	5	0	0%	-	-
San Joaquin River between Hog and Turner Cut	1999	5	0	0%	-	-
San Joaquin River near Stockton	1993	36	15	42%	37%	80%
	1998	5	0	0%	-	-
	1999	5	0	0%	-	-
	2003	4	0	0%	-	-
San Joaquin River near Vernalis	1991	35	0	0%	-	-
	1992	204	5	2%	26%	70%
	1993	290	50	17%	45%	89%
	1994	155	30	19%	46%	82%
	1995	17	4	24%	31%	59%
	1996	1	0	0%	-	-
	1997	45	0	0%	-	-
	1998	11	0	0%	-	-
	1999	41	0	0%	-	-
	2000	82	3	4%	13%	22%
	2001	109	12	11%	27%	40%
	2002	24	0	0%	-	-
	2003	33	0	0%	-	-
	2004	27	1	4%	11%	11%
	2005	15	0	0%	-	-
Smith Canal	1997	1	1	100%	62%	62%
Steamboat Slough	2001	6	0	0%	-	-
	2002	4	0	0%	-	-
	2003	25	1	4%	24%	24%
Sutter Slough	2001	2	0	0%	-	-
Sycamore Slough	1995	1	0	0%	-	-
Terminous Tract Drain	2005	2	0	0%	-	-
Tom Paine Slough	2001	5	0	0%	-	-
Ulatis Creek	1992	6	2	33%	33%	33%
	1993	2	2	100%	54%	55%

Table C-1. Comparison of Concentration data with the proposed Loading Capacity

Location	Water Year[i]	# of samples	# of samples > LC	% of samples > LC	avg % reduction needed to meet LC during exceedances	max % reduction needed to meet LC
	1994	4	4	100%	48%	72%
	1995	7	4	57%	68%	86%
	2002	4	0	0%	-	-
	2003	30	10	33%	61%	81%
	2004	19	10	53%	64%	82%
Walker Slough	2001	5	1	20%	29%	29%
Whiskey Slough	2001	5	0	0%	-	-
Yolo Bypass at I-80	1997	2	0	0%	-	-
	1998	2	0	0%	-	-
	1999	1	0	0%	-	-
	2000	1	0	0%	-	-

[i] Water years span from October of the previous calendar year through September. For example, the 1997 water year was from October 1, 1996 through September 31, 1997.

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL VALLEY REGION

Amendments to the Water Quality Control Plan For the Sacramento River and San Joaquin River Basins

For

The Control of Diazinon and Chlorpyrifos Runoff into the Sacramento-San Joaquin Delta

Appendix D

Cost Calculations

January, 2006 Peer Review Draft

D1. Introduction

Appendix D contains tables showing the calculations used to determine the potential cost of implementing the proposed Basin Plan amendment, including implementation of management practices, monitoring and planning alternatives. These tables are followed by definitions, endnotes, and citations for the information presented.

Table D-1. Total Estimated Costs For the Implementing the Proposed Basin Plan Amendment

	Low Cost Estimate ($/yr)[1]	High Cost Estimate ($/yr)
Dormant Season Practices (See Table D-2)	-15,050	160,175
Irrigation Season Practices (See Table D-3)	5,895,336	12,483,858
Monitoring and Planning Costs (See Tables D-4 and D-5)	500,092	1,773,000
Total	6,380,378	14,417,033

Table D-2 Estimated Cost For Dormant Season Management Practices (Based on cost estimates from Beaulaurier et al., 2005)

Crop	Acres Treated with Chlorpyrifos During Dormant Season[2]	Low Cost $ /acre-yr	high cost $/acre-yr	Low Cost $/yr	High Cost $/yr
Almonds	114	-14	149	-1,596	16,986
Cherries	17	-14	149	-238	2,533
Apples	944	-14	149	-13,216	140,656
total				**-15,050**	**160,175**

[1] Negative values indicate a cost savings.
[2] New diazinon label requirements (MANA, 2004) are expected to adequately control dormant season diazinon discharges. Therefore, costs of implementing management practices for diazinon use during the dormant season are not included in these calculations.

Table D-3 Cost Estimates for Implementation of Irrigation Season Management Practices

Crop	Crop Type	Acres Treated with Diazinon or Chlorpyrifos during Irrigation Season	% of acres applicable	low cost $/acre-yr (see Tables D-7 and D-8)	high cost $/acre-yr (see Tables D-7 and D-8)	low cost $/yr	high cost $/yr
Pears	orchard	3,296	60	60	196	118,656	387,610
Cherries	orchard	1,835	60	60	196	66,060	215,796
Walnuts	orchard	26,933	60	60	196	969,588	3,167,321
Plums	orchard	956	60	60	196	34,416	112,426
Apples	orchard	3,338	60	60	196	120,168	392,549
Almonds	orchard	9,793	60	60	196	352,548	1,151,657
Tomatoes	field and row	4,876	100	75	100	292,560	487,600
Melons	field and row	807	100	60	100	48,420	80,700
Alfalfa	field and row	56,842	100	60	100	3,410,520	5,684,200
Corn	field and row	2,829	100	60	100	169,740	282,900
Asparagus	field and row	1,573	100	60	100	94,380	157,300
Cotton	field and row	992	100	60	100	59,520	99,200
Grapes	field and row	2,241	100	60	100	134,460	224,100
Sunflowers	field and row	405	100	60	100	24,300	40,500
Total						**5,895,336**	**12,483,858**

Table D-4 Estimated Monitoring and Planning Costs for Watershed Group Compliance

Water Quality Monitoring Cost	
Number of Sites	48
Number of Environmental Samples (See Table D-5)	962
Total # of samples including 30% QA/QC Samples	1,251
Cost per Sample	$ 200
Total Analytical Costs	$ 250,120
Number of Toxicity Samples	20
Total Cost of Toxicity Analyses (assumes 1,000 per sample average cost)	$ 20,000
Number of Pyrethroid Samples	20
Total Cost of Pryrethroid Samples	$ 4,000
Number of Person-days for sample collection. Assumes 2 person crew can cover 6 sites.	321
Sample collection preparation as a percent of Person-days for sampling.	25%
Total Person-days for Sample Collection & Preparation	401
Cost per Person-day	$ 150
Sampling personnel cost	$ 60,150
Travel Costs (assumes each person day involves 300 miles of driving at 0.35 per mile)	$ 29,822
Equipment/Supplies	$ 20,000
Monitoring Plan & Quality Assurance Plan (Assumes 1 person month @ 10,000 per person month)	$ 10,000
Monitoring Program Coordination (Assumes 1 year at 50% time at 10,000 per person month)	$ 60,000
Annual Monitoring Report	$ 30,000
Total Monitoring Cost	**$ 380,092**
Planning and Evaluation Cost	
Implementation Plan (Assumes 3 person months @ 10,000 per person month)	$ 30,000
Implementation Plan Coordination, Delta Watershed - Wide (assumes 12 months at 50% time at 10,000 per person month)	$ 60,000
Annual Implementation Report, Including Practices Effectiveness Evaluation (Assumes 3 months at 10,000 per person month)	$ 30,000
Total Planning and Evaluation Cost	**$ 120,000**
Total annual cost for basin-wide monitoring, planning, and evaluation	
Total Cost	**$ 500,092**
Total Number of Growers	900
Cost per Grower	**$ 556**

Table D-5 Estimated Monitoring and Planning Costs for Individual Compliance

Water Quality Monitoring Cost	
Number of Tailwater Samples Collected per site	2
% QA/QC Samples	30%
Total # of samples	3
Cost per Sample	$ 200
Total analytical costs per site	$ 600
Cost for sampling collection and flow estimate (including preparation and shipping). Assumes 2 hrs per sample @ 40/hr.	$ 160
Travel Costs (50 mi per trip/ 0.35 per mile.)	$ 35
Bottles and Supplies (5/sample)	$ 15
Monitoring and Quality Assurance Plan. Assumes 8 hours time @ 40/hr	$ 320
Annual Monitoring Report (assume 8 hrs time @ 40/hr)	$ 320
Total Monitoring Cost per Site	**$ 1,650**
Planning and Evaluation Cost	
Implementation Plan (Assumes 4 hours @ 40 per person hour)	$ 160
Annual Implementation Plan Report Including Effectiveness Evaluation (Assumes 4 hours @ 40 per person hour)	$ 160
Total planning cost	**$ 320**
Total annual cost for basin-wide monitoring, planning, and evaluation	
Cost per Grower (assumes 1 monitoring site per grower)	**$ 1,970**
Total Number of Growers	900
Basin-wide Cost	**$ 1,773,000**

Table D-6. Estimated Number of Samples For Watershed-Based Compliance Monitoring

	Sites	Storms	OP Samples per Storm	Storm OP Samples/Yr	Irrigation OP Samples/ Station	Irrigation OP Samples/Yr	Toxicity Samples/Yr	Pyrethorid Samples/Yr
Delta Rivers								
Cache Slough nr outlet	1	5	6	30	12	12		
Sac R. at Freeport	1	5	6	30	12	12		
Sac R at Rio Vista	1	5	7	35	12	12	5	5
Sac R nr Outlet	1	0	0	0	0	0		
SJR at Stockton	1	5	3	15	12	12		
SJR near Antioch	1	0	0	0	0	0		
Mokelumne R d/s Geogiana Slough	1	5	3	15	12	12		
Old R nr Tracy	1	5	3	15	12	12		
Old R nr Bacon Island	1	5	3	15	12	12		
Middle R nr Union Island	1	5	3	15	12	12		
Middle R nr Middle R. CA	1	5	3	15	12	12		
Major Delta Tributaries								
Sacramento	1	*	*	*	*	*		
Colusa Basin Drain	1	*	*	*	12	12		
San Joaquin	1	*	*	*	*	*		
Yolo bypass	1	5	6	30	12	12		
Cosumnes R	1	5	3	15	12	12		
Mokelumne R	1	5	3	15	12	12		
Calaveras R	1	5	3	15	12	12		
Other Delta Tributaries and Waterways (see Appendix E for a description of the Delta Subareas)								
Central Delta								
Delta Waterways	2	5	1	10	12	24		
Island Drains	1	5	1	5	6	6		
Eastern Delta and Tributary Area								
Back Sloughs	2	5	1	10	12	24	5	5
Delta Waterways	2	5	1	10	12	24		

	Sites	Storms	OP Samples per Storm	Storm OP Samples/Yr	Irrigation OP Samples/ Station	Irrigation OP Samples/Yr	Toxicity Samples/Yr	Pyrethorid Samples/Yr
Small Upland Drainages	2	5	3	30	12	24		
Island Drains	1	5	1	5	6	6		
Northern Delta								
Back Sloughs	2	5	1	10	12	24		
Delta Waterways	2	5	1	10	12	24		
Island Drains	1	5	1	5	6	6		
Northwest Delta and Tributary Area								
Back Sloughs	2	5	1	10	12	24	5	5
Delta Waterways	2	5	1	10	12	24		
Small Upland Drainages	2	5	3	30	12	24		
Island Drains	1	5	1	5	6	6		
Southern Delta and Tributary Area								
Back Sloughs	2	5	1	10	12	24	5	5
Delta Waterways	2	5	1	10	12	24		
Island Drains	1	5	1	5	6	6		
Western Delta and Tributary Area								
Delta Waterways	0	0	0	0	12	0		
Small Upland Drainages	2	5	3	30	12	24		
Island Drains	1	5	1	5	6	6		
Totals	48			470		492	20	20

Table D-7 Economic Analysis for Irrigation Season Chlorpyrifos and Alternate Scenarios for Alfalfa (from Beaulaurier et al., 2005 with minor corrections, based on Cost Data from UCCE, 2003).

Chlorpyrifos applied in-season (March) to control Egyptian Alfalfa Weevil		**Base Case**	**Alternate Scenario 1**	**Alternate Scenario 2**
		Chlorpyrifos, Flood irrigation, no tailwater control or vegetated buffer	Same irrigation as Base Case, tailwater control to reduce runoff	Same irrigation as Base Case, vegetated buffer to reduce runoff
Cost of One Application(per ac, based on 100 ac)(a)	20/acre	20	20	20
Lorsban 4E (2qt/ac)(3)(a)	15/acre	15	15	15
Vegetated Buffer(c)	60/acre			60
Tailwater control (Surface Drainage recirculation)(f)	100/acre		100	
Cultural Costs--Not Including management variable(d)		290	290	290
Total Cultural Costs		325	425	385
Harvest Costs per acre(d)		198	198	198
Interest on Operating Capital @7.14%(d)		9	9	9
Cash Overhead(d)		77	77	77
Non-Cash Overhead(d)		400	400	400
Total Costs		1,009	1,109	1,069
Gross Revenue (5)(d)		875	875	875
Returns to Land, Mgt & Overhead		- 134	- 234	- 194
Total Cultural Costs as Percent of Gross Revenue		37%	49%	44%
Total Costs as Percent of Gross Revenue		115%	127%	122%
Change in Total Cost from Base Case		0	100	60
% Change in Total Cost from Base Case		0%	10%	6%

Table D-8 Economic Analysis for Irrigation Season Chlorpyrifos (Base Case) and Alternate Scenarios for Almonds. (Modified from Beaulaurier et al., 2005, based on UCCE 2002a, 2002b)

Chlorpyrifos applied in-season (July) to control Naval Orange Worm			**Base Case**	**Alternate Scenario 1**	**Alternate Scenario 2**	**Alternate Scenario 3**	**Alternate Scenario 4**
			Chlorpyrifos with flood irrigation	Orchard sanitation + *Bt* at hull split. flood irrigation	Chlorpyrifos flood irrigation, cover crops to reduce runoff	Guthion, flood irrigation, cover crops to reduce runoff	Chlorpyrifos, 100% of growers use drip or microsprinklers to reduce runoff.
	Cost of One Application(per ac, based on 100 ac)(a)		20		20	20	20
	Cost of Two Applications(per ac, based on 100 ac)(a)			40			
	Lorsban 4E (2qt/ac)(3)(a)(g)	15/acre	15		15		15
	Guthion 50WP (4lbs/ac)(3)(a)(b)	45/acre				45	
	Dipel (1 lb/ac)(2)(a)	28/acre		28			
	Orchard sanitation (c)	70/acre		70			
	Cover Crop(c)	60/acre			60	60	
	Microsprinklers						196
Cultural Costs--Not Including management variable(d,e)			1,000	1,000	1,000	1,000	1,000
Total Cultural Costs			1,035	1,138	1,095	1,125	1,231
Harvest Costs per acre(d)			332	332	332	332	332
Interest on Operating Capital @7.4%(d)			24	24	24	24	24
Cash Overhead(d)			214	214	214	214	214
Non-Cash Overhead(d)			1,098	1,098	1,098	1,098	1,098
Total Costs			2,703	2,806	2,763	2,793	2,899
Gross Revenue (5)(d)			2,500	2,500	2,500	2,500	2,500
Returns to Land, Mgt & Overhead			- 203	- 306	- 263	- 293	- 399
Total Cultural Costs as Percent of Gross Revenue			41%	46%	44%	45%	49%

Chlorpyrifos applied in-season (July) to control Naval Orange Worm	Base Case	Alternate Scenario 1	Alternate Scenario 2	Alternate Scenario 3	Alternate Scenario 4
Total Costs as Percent of Gross Revenue	108%	112%	111%	112%	116%
Change in Total Cost from Base Case	**0**	**103**	**60**	**90**	**196**
% Change in Total Cost from Base Case	0%	4%	2%	3%	7%

D2. Endnotes

a) Costs are from Zalom, et al., 1999.
b) Guthion (azinphos-methyl) was used for scenario 3 because it was first on list of alternatives from UCIPM guidelines.
c) Costs are from Thomas, F. CERUS Consulting. Personal Communication.
d) Costs for typical practices are from University of California Cooperative Extension --see citations below. Specific practices vary by crop.
e) Includes cost of removing mummies for control of Naval Orange Worm in almonds (70 per acre)
f) Cost estimated as annualized capital cost of 45 plus annual maintenance cost of 55. Annualized capital cost = 812 capital cost/18year life expectancy.
g) A pyrethroid scenario was not included because pyrethroids are not recommended for in-season use on almonds.

2) Two applications required--cost is for two applications
3) One to three applications required when used as an in-season treatment; cost is for one application
5) Cost data are for 1998 (except advisory board assessment), an inflation rate of 3% was applied to all costs. Yield, price, and advisory board assessment data are for 2003 (R. Duncan, pers. comm.. Yield for almonds: 1 ton per acre Price per ton: 2500.

D3. Definitions

"Cultural Costs--Not Including Management Alternative(s)" includes annual cost per acre for typical cultural practices such as irrigation using flood system, pruning, fertilization, pollination, leaf analysis, non-dormant season insect pest control, vertebrate pest, weed, and disease control, vehicle use, and consultant fees. It does not include the cost of the management alternative being compared in the scenario, e.g., a specific pesticide.
"Harvest Costs" include shaking, raking, sweeping, pickup and haul, hull and shell, bin distribution, hand picking, and field sorting, depending on the crop type.
"Processing Costs" include cooling, sorting, packing, and storing. These costs apply to apples only
"Advisory Board Assessment" is a mandatory fee assessed on each ton harvested. Not all crops are assessed an advisory board fee.
"Interest on Operating Capital" is based on cash operating costs and is calculated monthly until harvest at a yearly rate that varies by crop.
"Cash Overhead" are expenses assigned to the whole farm including office expenses, sanitation fees, property taxes, insurance, and equipment repairs
"Non-Cash Overhead" includes buildings, fuel tanks, shop and hand tools, irrigation pumps, filters, and sprinklers, land, and orchard establishment costs.
"Gross Revenues" is the price paid per ton, times the number of tons typically harvested per acre. Tons per acre and price per ton for each crop is identified in (5), above
"Returns to Land, Management, and Overhead" is the difference between Gross Revenues and Total Costs per acre.

D4. Citations

Beaulaurier, D., G. Davis, J. Karkoski, M. McCarthy, D. McClure, M. Menconi. 2005. Amendments to the Water Quality Control Plan for the Sacramento River and San Joaquin River Basins for the Control of Diazinon and Chlorpyrifos Runoff into the Lower San Joaquin River.

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UCCE. 2003. *Sample Costs to Establish and Produce Alfalfa*. San Joaquin Valley 300 Acre Planting. University of California Cooperative Extension (UCCE).

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL VALLEY REGION

Amendments to the Water Quality Control Plan For the Sacramento River and San Joaquin River Basins

For

The Control of Diazinon and Chlorpyrifos Runoff into the Sacramento-San Joaquin Delta

Appendix E

Detailed Background Information for Seven Geographic Subareas Within the Delta Watershed

January, 2006 Peer Review Draft

Introduction

This appendix provides additional background information to supplement that provided in Chapter 2 of the main report. Since the Delta watershed is large and varied in terms of topography, hydrology, and water sources, seven subareas were defined within the Delta watershed boundary based on dominant hydrologic characteristics in order to facilitate detailed evaluations of diazinon and chlorpyrifos use, transport, and presence in surface waters. The seven subareas are the Colusa Basin, Northwestern Delta and Tributary Area, Northern Delta, Eastern Delta and Tributary Area, Southern Delta and Tributary Area, Central Delta and Western Delta and Tributary Area, as shown in Figure E-1. Pesticide use, geographic extent, general hydrology, and diazinon and chlorpyrifos surface water concentrations are discussed for each subarea.

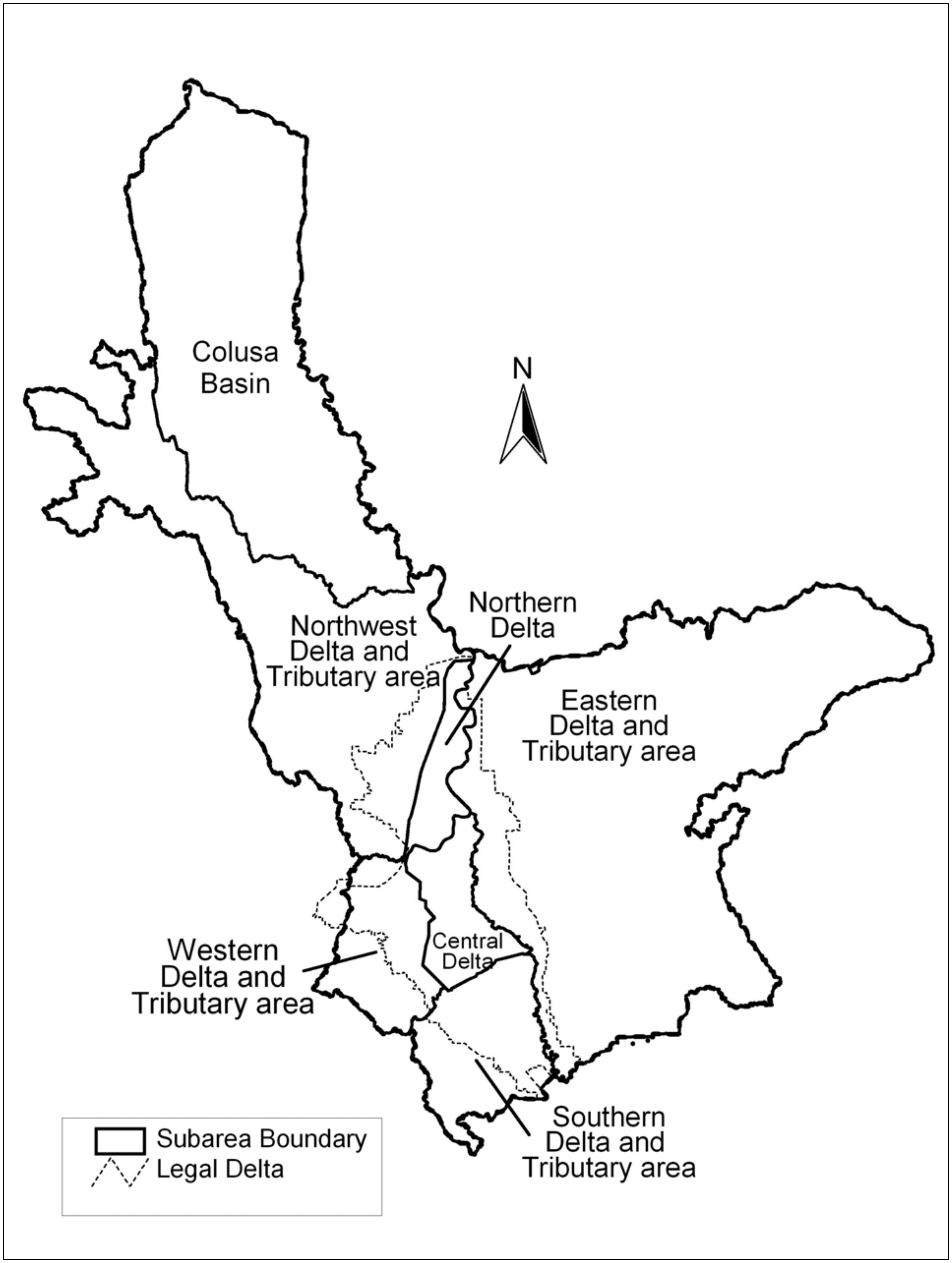

Figure E-1 Seven Delta Subareas

Diazinon and Chlorpyrifos Use in the Seven Delta Subareas

Table E-1 shows the annual average agricultural use of diazinon and chlorpyrifos in the seven Delta subareas, using pesticide use data from 1999-2003 (DPR, 2004). While there is significant reported agricultural usage in all the subareas, the annual average use varies significantly as do the relative quantities of diazinon and chlorpyrifos used in each subarea. In the Northern and Western Delta, more diazinon is applied than chlorpyrifos. In the other subareas, more chlorpyrifos is used than diazinon.

Tables E-2 and E-3 summarize the highest reported agricultural diazinon and chlorpyrifos uses by the subareas in which they occur. These tables show that the different Delta subareas have diverse uses of diazinon and chlorpyrifos. The major diazinon applications by crop and subarea (averaging approximately 1,000 lbs/year or greater) are: almonds in the Colusa Basin and Eastern Delta, tomatoes in the Colusa Basin, Northwest and Southern Delta and Tributary Areas, plums (dried and fresh) in the Colusa Basin and Northwest Delta and Tributary Area, cherries in the Eastern Delta, pears in the Northern Delta and apples in the Eastern Delta and Tributary Area. The major chlorpyrifos applications by crop and subarea (averaging approximately 1000 lbs/year or greater) are walnuts in all subareas except the Central Delta and the Western Delta and Tributary Area (but with the greatest amount used by far in the Eastern Delta and Tributary Area), alfalfa in all subareas except the Western Delta, almonds in the Colusa Basin, Eastern and Northwest Delta and Tributary Areas, corn and apples in the Eastern Delta and Tributary Area, asparagus in the Central Delta, cotton in the Colusa Basin, and grapes in the Eastern Delta and Tributary Area.

Table E-1 Diazinon and Chlorpyrifos Agricultural Use by Subarea

Delta Subarea	Size of Subarea (Acres)	Annual Average Use (lbs, 1999-2003)	
		Diazinon	Chlorpyrifos
Central Delta	141,800	355	3,501
Colusa Basin	1,103,266	15,814	21,548
Eastern Delta and Tributary Area	1,751,972	17,824	49,391
Northern Delta	92,995	4,396	3,690
Northwest Delta and Tributary Area	910,202	5,628	23,322
Southern Delta and Tributary Area	248,578	2,036	12,141
Western Delta and Tributary Area	202,072	1,599	508
TOTAL	4,450,885	47,652	114,101

Table E-2 Major Agricultural Diazinon Uses by Crop and Subarea (1999-2003 Annual Average Pounds Applied)

Crop	Delta Watershed Subarea						
	Central	Colusa Basin	Eastern	Northern	Northwest	Southern	Western
Almonds	0	6,416	7,576	0	258	123	0
Tomatoes	141	2,882	624	178	1,922	1,316	1
Plums	0	4,774	14	6	1,790	0	26
Cherries	0	2	5,633	110	24	2	168
Pears	205	2	427	3,677	2	0	3
Apples	4	1	1,354	381	32	0	906

Table E-3 Major Agricultural Chlorpyrifos Uses by Crop and Subarea (1999-2003 Annual Average Pounds Applied)

Crop	Delta Watershed Subarea						
	Central	Colusa Basin	Eastern	Northern	Northwest	Southern	Western
Walnuts	15	6,137	22,617	76	10,422	1,427	70
Alfalfa	1,555	4,749	10,612	1,357	9,003	8,381	97
Almonds	0	7,040	6,524	0	753	301	2
Corn	26	298	3,792	0	502	254	127
Sugarbeets*	87	401	1,238	554	894	804	2
Apples**	4	421	*2,367*	460	37	106	204
Asparagus	1,814	3	622	14	3	767	0
Cotton	0	1,656	0	0	274	84	0
Grapes	0	8	989	140	0	0	6

* Sugarbeets are no longer grown in significant quantities in or around the Delta.
** Use of chlorpyrifos on apples has been canceled

The Colusa Basin

The Colusa Basin subarea includes all the area that drains into the Colusa Basin Drain, extending from near Orland on the north southward past the cities of Willows, Colusa, and Williams to just north of Woodland. The surface water in the Colusa Basin consists of local runoff from irrigation and rainfall within the Colusa Basin. The Colusa Basin subarea is bound on the north and west by the boundaries of the Colusa Basin Drain's watershed, on the east by the western levee of the Sacramento River, and on the south by the Northwest Delta and Tributary Subarea. This basin is addressed in both this Basin Plan Amendment and the Sacramento River Diazinon TMDL (Karkoski et al., 2003). The runoff in the Colusa Basin Drain can either drain directly into the Sacramento River upstream of the Delta near Knights Landing, or it can be all or partially diverted south into the Delta via the Knights Landing Ridge Cut and the Yolo Bypass for water supply or for flood control when the water level in the Sacramento River is high following winter storms. Figure E2 shows the Colusa Basin and the monitoring site from which pesticide concentration data were obtained for this report.

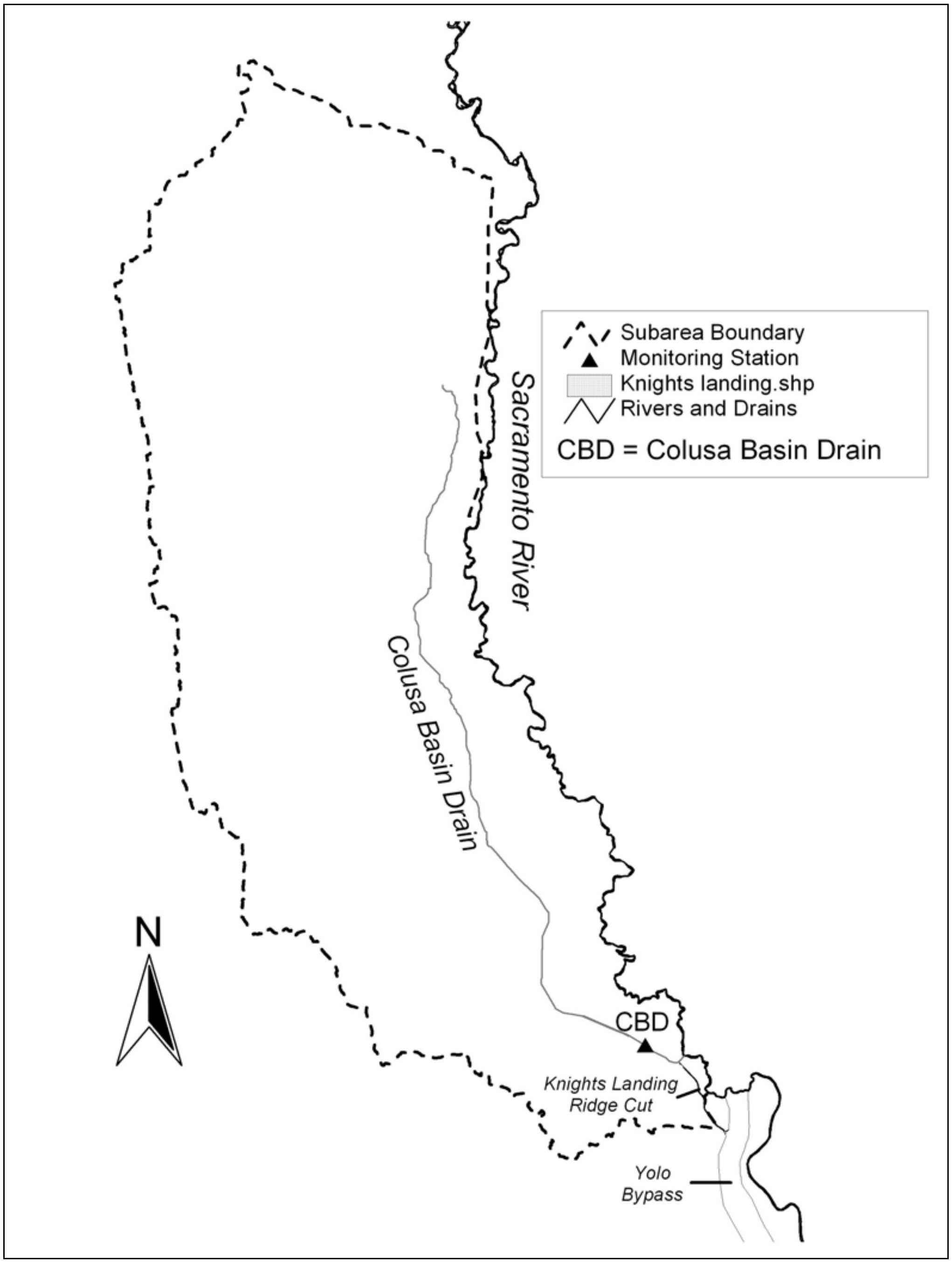

Figure E2. The Colusa Basin

Diazinon and Chlorpyrifos Use in the Colusa Basin

Agricultural diazinon use in the Colusa Basin averages approximately 16,000 pounds per year, based on use data from 1999-2003. The main crops on which diazinon is used in this subarea are almonds, plums and prunes, and tomatoes. Agricultural chlorpyrifos use in the Colusa Basin averages approximately 22,000 pounds per year, based on use data from 1999-2003, with the main uses being almonds, walnuts and alfalfa and cotton.

Diazinon and Chlorpyrifos in the Colusa Basin Drain

Almost all of the Colusa Basin drains to the Colusa Basin Drain. The Colusa Basin Drain at Knights Landing, just upstream of where it drains into the Knights Landing Ridge Cut, and/or the Sacramento River is a good integrator site for determining the loads and concentrations that are discharged from this basin into the Yolo Bypass and/or the Sacramento River. Table 2.17 shows diazinon and chlorpyrifos concentrations measured in the Colusa Basin Drain at Knights Landing. The available data indicate that the concentrations of diazinon and chlorpyrifos both occasionally exceed the proposed criteria for these pesticides, but diazinon tends to be present at levels of concern much more frequently. This site had the highest chlorpyrifos concentration in the entire data set for the Delta watershed (700 ng/L on 6/22/2001).

Table E4. Diazinon and Chlorpyrifos Concentrations for the Colusa Basin Drain Near Knights Landing

Diazinon					
# of Samples	Median Conc. (ng/L)	90th Percentile Conc. (ng/L)	Maximum Conc. (ng/L)	# of Samples >160 ng/L	% of samples > 160 ng/L
170	20	120	420	13	8%
Chlorpyrifos					
# of Samples	Median Conc. (ng/L)	90th Percentile Conc. (ng/L)	Maximum Conc. (ng/L)	# of Samples > 25 ng/L	% of samples > 25 ng/L
87	0	0	700	1	1%
Combined Criteria-Normalized Diazinon and Chlorpyrifos					
# of Samples	Median S[1] Value	90th Percentile S Value	Maximum S value	# of Samples S > 1	% of samples S > 1
74	0.1	0.6	28.0	4	5%

[1] S = The sum of the criteria-normalized diazinon and chlorpyrifos concentrations as defined by Equation 1 in Section 2.3.3 of the main report.

Northwest Delta and Tributary Subarea

The Northwest Delta and Tributary subarea includes the northwest corner of the legal Delta as well as the lands and waterways to the northwest of the legal Delta that drain into the Delta. The surface water within the Northwestern Delta and Tributary subarea is mostly water from upstream reservoir releases and runoff from irrigation and rainfall, but also consists of tidal flows from the Northern Delta. At high flows, the surface water within the Northwestern Delta and Tributary subarea also contains Sacramento River water that flows into the Yolo Bypass via Fremont and Sacramento Weirs, and contains Colusa Basin Drain water that flows into the Yolo Bypass via the Knights Landing Ridge Cut. Nearly all of the Northwest Delta and Tributary subarea drains into the Sacramento River in the Northern Delta via Cache Slough. The Northwest Delta and Tributary subarea is bound on the north by the Colusa Basin subarea, on the east by the western levees along the Sacramento River and the Sacramento River Deepwater Ship Channel, on the south by the Western Delta and Tributary subarea, and on the west by the upstream extents of the Putah and Cache Creek watersheds downstream of Clear Lake and Lake Berryessa, respectively. The Northwest Delta and Tributary subarea includes the watersheds of lower Putah and Cache creeks and the other tributaries of the Yolo Bypass, as well as the areas to the west of the Yolo Bypass that drain southward to Sacramento River upstream of the cities of Rio Vista, and encompasses Winters, Woodland, West Sacramento, Rio Vista, and Vacaville.

The Yolo Bypass is a levied floodplain that carries floodwaters from the Sacramento River and several other Central Valley waterways into the Delta. The Yolo Bypass begins at the Fremont Weir, just across the Sacramento River from the terminus of the Sutter Bypass. When the flows in the Sacramento River are high from storm runoff, significant portions of Sacramento River flows enter the Yolo Bypass via the Fremont Weir and the Sacramento Weir. The Yolo Bypass is bound by levees on its western side and is bound on its eastern side by the Tule Drain (which becomes the Toe Drain in its southern reach) and the East Bypass levee. When not flooded, the land in the Yolo Bypass is used for growing agricultural crops such as rice, tomatoes and corn, and for managed wetland habitat. The Knights Landing Ridge Cut conveys water from the Colusa Basin into the Yolo Bypass just south of the Fremont Weir. Cache Creek flows southeast from Clear Lake into the Yolo Bypass near the city of Woodland. Willow Slough and the Willow Slough Bypass flow into the Yolo Bypass just north of the city of Davis. Putah Creek flows east from Lake Berryessa into the Putah Creek Sinks, which is in the Yolo Bypass just south of the city of Davis. The Yolo Bypass, the Sacramento Deepwater Ship Channel, Lindsey Slough, Prospect Slough, Miners Slough, and Steamboat Slough, all flow into Cache Slough before it empties into the Sacramento River just upstream of the city of Rio Vista. These tributaries of Cache Slough receive agricultural drainage from Yolo and Solano county farmland. Putah Creek receives treated wastewater discharges from the cities of Davis and Winters. Therefore, the water in the Northwest Delta and Tributary subarea is a mix of local runoff, including both agricultural and urban runoff; seasonal flows from the Colusa Basin; flows from the Sacramento Valley during high flows, when the Sacramento River flows into the Yolo Bypass; and tidal mixing from the Northern Delta. Figure E3 shows the Northwest Delta and Tributary subarea, and the monitoring sites from which pesticide concentration data were obtained for this report.

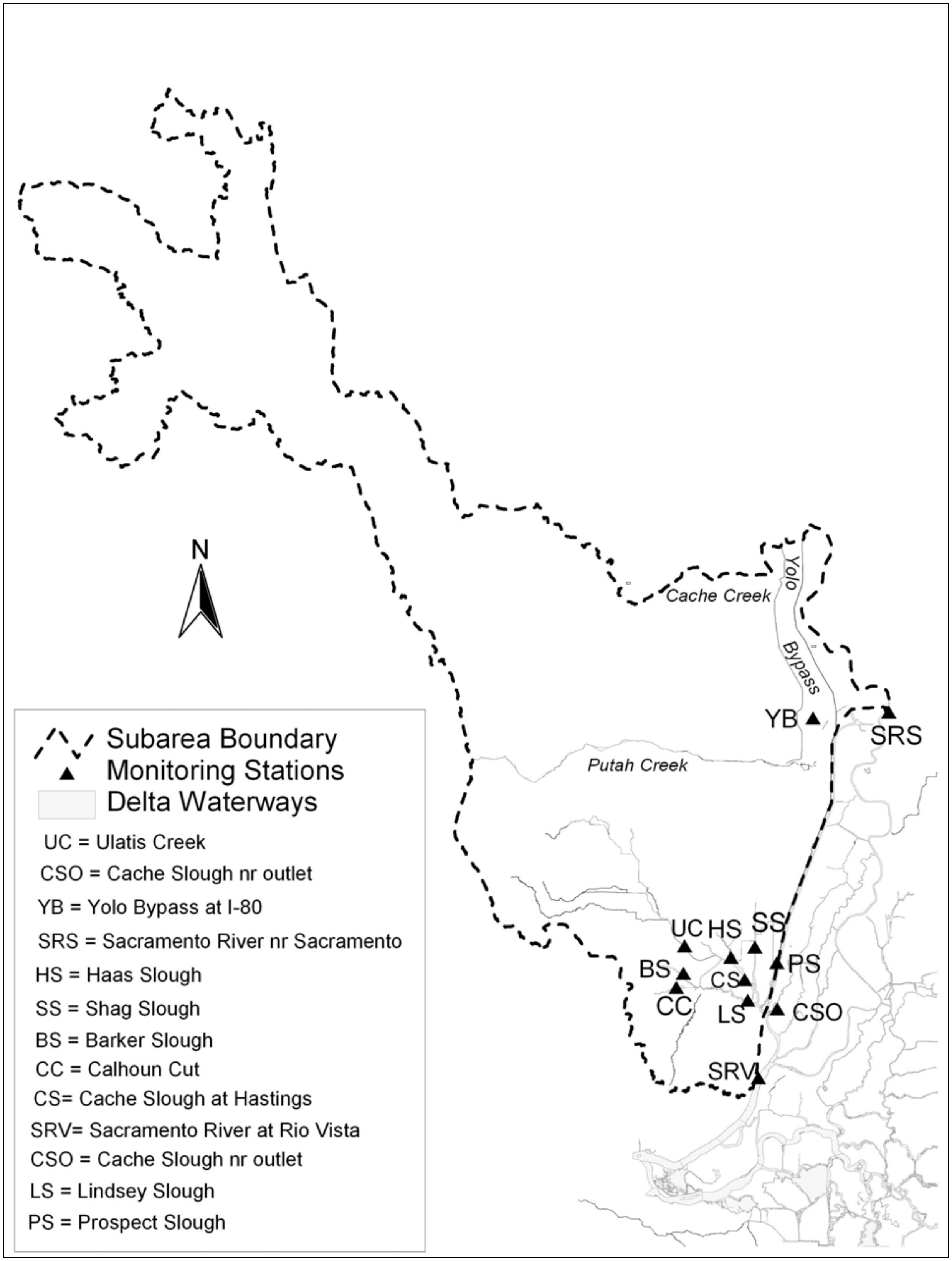

Figure E3. The Northwest Delta and Tributary Area

Diazinon and Chlorpyrifos Use in the Northwest Delta and Tributary Area

Agricultural diazinon use in the Northwest Delta and Tributary subarea averages approximately 5,600 pounds per year, based on use data from 1999-2003, with the main uses being on tomatoes and plums (dried and fresh). Agricultural chlorpyrifos use in the Northwest Delta and Tributary Area averages approximately 23,000 pounds per year, based on use data from 1999-2003, with the main uses being on walnuts and alfalfa.

Diazinon and Chlorpyrifos in the Northwest Delta and Tributary Area

Tables E5, E6, and E7 summarize diazinon and chlorpyrifos surface water concentration data for this subarea. Since nearly all of the Northwest Delta and Tributary area drains to Cache Slough, Cache Slough near its outlet makes a good integrator site for describing the contribution to the Delta pesticide loads from the Northwest Delta and Tributary subarea. Unfortunately, the available data for the Yolo Bypass and Cache Slough are very limited relative to the potential significance of the pesticide loading to the Delta from this tributary, particularly since the Yolo Bypass is the third largest source of flow into the Delta. Although there are limited data available for Cache Slough, the Yolo Bypass, or their tributaries, available water quality and pesticide use data indicate that these waterwaus may periodically carry significant diazinon and chlorpyrifos concentrations and loads into the Delta. The chlorpyrifos data for Cache Slough near its outlet occasionally exceed the proposed Water Quality Objective for chlorpyrifos, but the data set did not include any exceedances of the proposed objective for diazinon. Nevertheless, when the Yolo Bypass is flooded following January and February storms, it has the potential to carry significant diazinon loads from the Sacramento Valley into the Delta, since large quantities of Sacramento River water flow into the Yolo Bypass via Fremont Weir, and the diazinon concentrations in the Sacramento River near Fremont Weir[2] during winter storm flows range from below detections limits to 171 ng/L (Karkoski et al., 2003). Ulatis Creek is an agriculturally dominated upland drainage in this area, and the available data indicate that it frequently exceeds both the proposed diazinon and chlorpyrifos criteria. There are currently no available chlorpyrifos or diazinon data for Cache or Putah creeks.

[2] Reported concentration range is for the Sacramento River at Alamar (Veteran's Bridge), which is downstream of Fremont Weir

TableE5. Diazinon Data for the Northwest Delta and Tributary Area

Location	# of Samples	Median Conc. (ng/L)	90th Percentile Conc. (ng/L)	Maximum Conc. (ng/L)	# of Samples >160 ng/L	% of Samples > 160 ng/L
Yolo Bypass at I-80	6	30	52	53	0	0%
Calhoun Cut	6	0	5	10	0	0%
Haas Slough	1	49	49	49	0	0%
Lindsey Slough	27	0	9	21	0	0%
Ulatis Creek	73	9	100	380	5	7%
Barker Slough	11	10	50	55	0	0%
Prospect Slough	1	4	4	4	0	0%
Shag Slough	1	0	0	0	0	0%
Cache Slough at Hastings	22	0	18	46	0	0%
Cache Slough nr Outlet	49	9	37	96	0	0%

Table E6. Chlorpyrifos Data for the Northwest Data and Tributary Area

Location	# of Samples	Median Conc. (ng/L)	90th Percentile Conc. (ng/L)	Maximum Conc. (ng/L)	# of Samples > 25 ng/L	% of Samples > 25 ng/L
Yolo Bypass at I-80	6	0	0	0	0	0%
Calhoun Cut	6	0	0	0	0	0%
Haas Slough	1	0	0	0	0	0%
Lindsey Slough	27	0	1	9	0	0%
Ulatis Creek	73	8	91	137	28	38%
Barker Slough	11	0	0	0	0	0%
Prospect Slough	1	0	0	0	0	0%
Shag Slough	1	0	0	0	0	0%
Cache Slough at Hastings	22	0	5	12	0	0%
Cache Slough nr Outlet	49	0	4	36	1	2%

Table E7. Combined Criteria-Normalized Diazinon and Chlorpyrifos Data for the Northwest Data and Tributary Area

Location	# of Samples	Median S[1] Value	90th Percentile S Value	Maximum S value	# of Samples S > 1	% of Samples S > 1
Yolo Bypass at I-80	6	0.2	0.3	0.3	0	0%
Calhoun Cut	6	0.0	0.0	0.1	0	0%
Haas Slough	1	0.3	0.3	0.3	0	0%
Lindsey Slough	27	0.0	0.1	0.5	0	0%
Ulatis Creek	72	0.7	3.9	7.3	32	44%
Barker Slough	11	0.1	0.3	0.3	0	0%
Prospect Slough	1	0.0	0.0	0.0	0	0%
Shag Slough	1	0.0	0.0	0.0	0	0%
Cache Slough at Hastings	13	0.0	0.6	0.7	0	0%
Cache Slough nr Outlet	49	0.1	0.5	1.4	1	2%

[1] S = the sum of the criteria-normalized diazinon and chlorpyrifos concentrations as defined by Equation 1 in Section 2.3.3 of the main report.

Northern Delta Subarea

The Northern Delta subarea encompasses the northern part of the Legal Delta, reaching as far north as the Sacramento River at I Street bridge in the city of Sacramento (where the Sacramento River enters the Legal Delta) and as far south as the Sacramento River near Rio Vista. The western boundary of the Northern Delta subarea is defined in the north by the eastern levee of the Yolo Bypass, which is just west of the Sacramento River Deepwater Ship Channel. This boundary follows the west side of the Sacramento Deepwater Ship Channel to its intersection with Cache Slough, south of which the boundary is defined by the western extent of the upland watersheds that drain to the Sacramento River upstream of Rio Vista. The eastern boundary follows the eastern levee of the Sacramento River southward to the Delta Cross Channel. The southeastern boundary of the Northern Delta subarea extends just beyond the southeastern side of the Sacramento River upstream of the city of Rio Vista, containing the lands that drain to the Sacramento River from the southeast between the Delta Cross Channel and Rio Vista.

The surface water in the Northern Delta subarea is dominated by water from the Sacramento River, which is the largest tributary to the Delta. The Sacramento River enters the Delta at the city of Sacramento and flows through the Delta into Suisun Bay. During certain times of the year, some of the Sacramento River water is diverted through the Delta Cross Canal into the Mokelumne River where it flows into the Southern Delta for export. The surface water in the Northern Delta subarea also includes water from local agricultural island discharges, discharges from the Northwest Delta subarea via the Yolo Bypass/Cache Slough, flows from the Eastern Delta and Tributary subarea, and tidal mixing from the Western and Central Delta subareas. Figure E4 shows the Northern Delta subarea and the monitoring sites from which pesticide concentration data were obtained for this report.

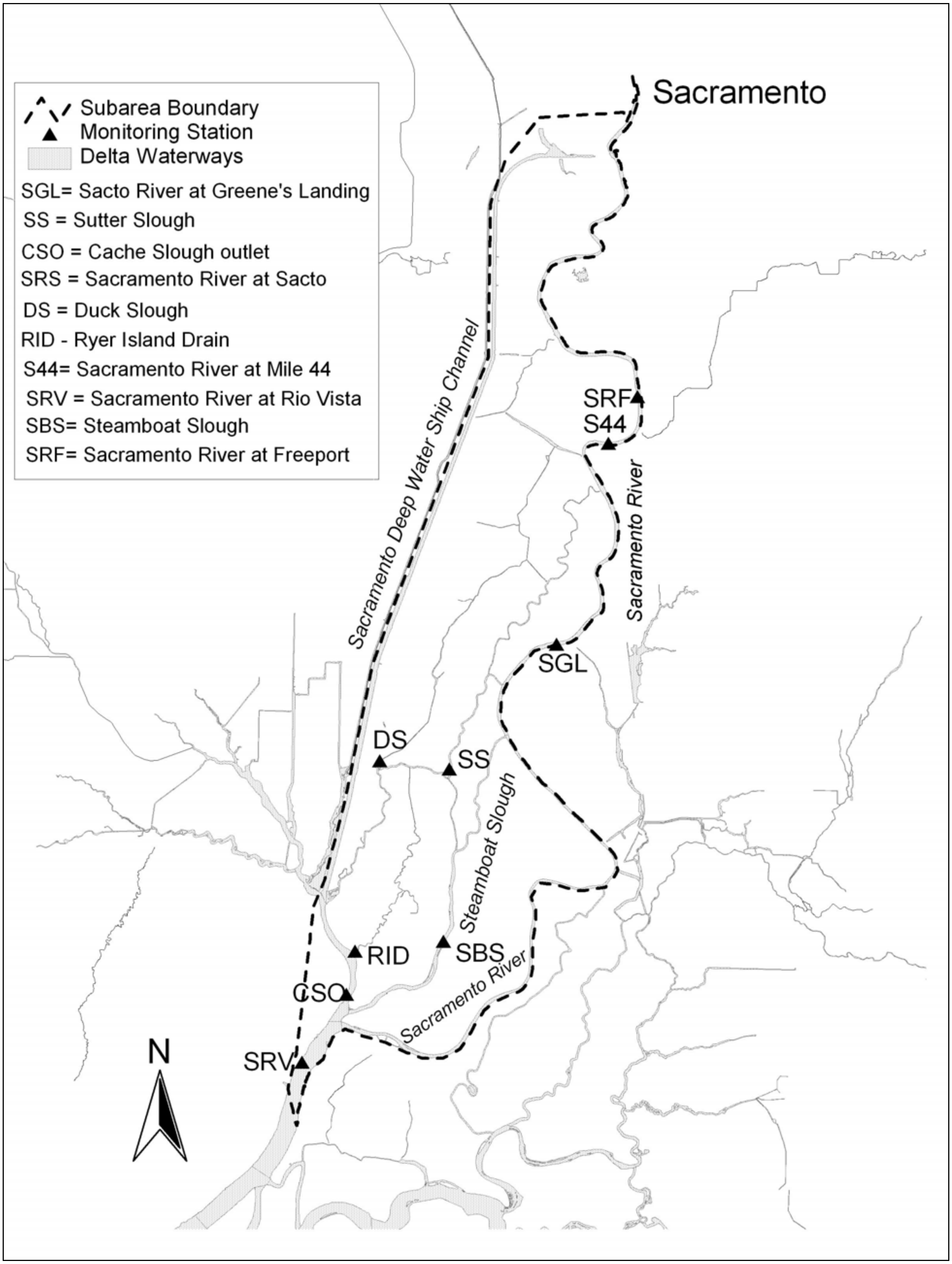

Figure E4. The Northern Delta Subarea

Diazinon and Chlorpyrifos Use in the Northern Delta Subarea

Agricultural diazinon use in the Northern Delta subarea averages approximately 4,400 pounds per year, based on use data from 1999-2003 with the main use being applications to pear orchards, which accounts for over 90% of the diazinon use in the Northern Delta subarea. Agricultural chlorpyrifos use in the Northern Delta subarea averages approximately 3,700 pounds per year, based on use data from 1999-2003 with the main uses being on alfalfa and apples.

Diazinon and Chlorpyrifos in the Northern Delta Subarea

Tables E8, E9 and E10 summarize diazinon and chlorpyrifos surface water concentration data for the Northern Delta subarea. The available data indicate the concentrations of diazinon occasionally exceed the proposed Water Quality Objectives in the Sacramento River within the Northern Delta subarea, and the chlorpyrifos concentrations occasionally exceed the proposed Water Quality Objectives in the Sacramento River and in Steamboat Slough, and more frequently in Duck Slough, an agriculturally dominated back slough.

Diazinon concentrations in the Sacramento River at the city of Sacramento range from below detectable levels to 307 ng/L, with the highest concentrations occurring following January and February storms. The timing of these elevated diazinon concentrations is coincident with the period of high diazinon use on nut and stonefruit trees during the dormant season, and also coincident with the period of heaviest rainfall in the Sacramento Valley and the Delta watershed. Elevated diazinon concentrations, combined with the high flows in the Sacramento River following winter storms, make January and February the time of year when the greatest diazinon loads enter the Delta from the Sacramento River. Daily diazinon loads in the Sacramento River during January and February of 1992-2001 range from approximately 200 grams per day to over 39,000 grams per day (Karkoski, et al., 2003). Diazinon concentrations in the Sacramento River within the delta have not been shown to exceed the proposed Water Quality Objectives outside of January and February.

Chlorpyrifos concentrations in the Sacramento River at the city of Sacramento are low compared with the San Joaquin River and other Delta tributaries, and exceedances of the proposed chlorpyrifos Water Quality Objectives are very infrequent in the Sacramento River at Sacramento. Since it is the downstream-most monitoring site, the Sacramento River at the city of Rio Vista makes a good integrator monitoring site to describe the concentrations of pesticides leaving the Northern Delta subarea. The presence of significant concentrations of chlorpyrifos in the Sacramento River at the city of Rio Vista indicates significant loads of chlorpyrifos are discharged into the Sacramento River within the Northern Delta subarea, since there appears to be less chlorpyrifos present in the Sacramento River upstream at the cities of Sacramento and Freeport.

Table E8. Diazinon Data for the Northern Delta

Location	# of Samples	Median Conc. (ng/L)	90th Percentile Conc. (ng/L)	Maximum Conc. (ng/L)	# of Samples >160 ng/L	% of Samples > 160 ng/L
Sac R at Sacramento	551	0	41	307	8	1%
Sac R at Freeport	189	0	12	140	0	0%
Sac R at Mile 44	70	0	0	70	0	0%
Sac R at Greene's Landing	6	24	167	280	1	17%
Sac R at Rio Vista	88	22	111	310	4	5%
Steamboat Slough	35	0	10	12	0	0%
Sutter Slough	2	0	0	0	0	0%
Duck Slough	47	0	27	58	0	0%
Ryer Island Drain	2	0	0	0	0	0%

Table E9. Chlorpyrifos Data for the Northern Delta

Location	# of Samples	Median Conc. (ng/L)	90th Percentile Conc. (ng/L)	Maximum Conc. (ng/L)	# of Samples > 25 ng/L	% of Samples > 25 ng/L
Sac R at Sacramento	520	0	0	30	1	0%
Sac R at Freeport	99	0	0	6	0	0%
Sac R at Mile 44	29	0	0	63	1	3%
Sac R at Greene's Landing	13	0	0	0	0	0%
Sac R at Rio Vista	89	0	0	36	2	2%
Steamboat Slough	35	0	0	33	1	3%
Sutter Slough	2	0	0	0	0	0%
Duck Slough	49	0	314	677	12	24%
Ryer Island Drain	2	0	0	0	0	0%

Table E10. Combined Criteria-Normalized Diazinon and Chlorpyrifos Data for the Northern Delta

Location	# of Samples	Median S[1] Value	90th Percentile S Value	Maximum S Value	# of Samples S > 1	% of Samples S > 1
Sac R at Sacramento	521	0.0	0.3	1.9	9	2%
Sac R at Freeport	98	0.0	0.1	0.3	0	0%
Sac R at Mile 44	26	0.0	0.0	2.5	1	4%
Sac R at Greene's Landing	1	1.8	1.8	1.8	1	100%
Sac R at Rio Vista	88	0.1	0.8	1.9	6	7%
Steamboat Slough	35	0.0	0.1	1.3	1	3%
Sutter Slough	2	0.0	0.0	0.0	0	0%
Duck Slough	47	0.1	11.4	27.3	12	26%
Ryer Island Drain	2	0.0	0.0	0.0	0	0%

[1] S = the sum of the criteria-normalized diazinon and chlorpyrifos concentrations as defined by Equation 1 in Section 2.3.3 of the main report.

Eastern Delta and Tributary Subarea

The Eastern Delta and Tributary subarea contains the area in the Delta east of the Sacramento River downstream of the legal Delta boundary, and includes the South Mokelumne River, Little Potato Slough, Little Connection Slough, and the San Joaquin River/Stockton Deepwater Ship Channel downstream of the Legal Delta boundary, and extends east into the Sierra foothills as far as the mountainous regions southeast of Placerville and includes the communities of Cameron Park, El Dorado Hills, Plymouth, Sutter Creek, Amador City, Jackson, Ione, Sacramento (south of the American River), Galt, Lodi, Manteca, Escalon, Ripon and Stockton. This subarea includes upland the reaches of the Mokelumne, Cosumnes and Calaveras rivers and numerous small creeks. The surface water within the Eastern Delta and Tributary subarea consists of waters from upstream reservoir releases, runoff from irrigation and rainfall within the Eastern Delta and Tributary subarea, and to a much lesser extent, water from tidal mixing from the adjacent Northern, Central and Southern Delta subareas.

The major tributaries entering the Delta from the East in this area include (from North to South) the Cosumnes River, the Mokelumne River, Bear Creek, Mosher Slough, Five Mile Slough, the Calaveras River, Mormon Slough, and French Camp Slough. These waterbodies receive runoff and drainage from agricultural and urban lands as they flow towards the Delta. Mosher Slough's, Five Mile Slough's, and Mormon Slough's watersheds include agricultural lands as well as urban lands in the Stockton area. While the flows from the Eastern Delta tributaries are smaller relative to the flows of the major rivers in the Delta (approximately 5% of total Delta inflows (DWR, 1995)), the diazinon and chlorpyrifos loads from these waterbodies can greatly affect the water quality in the Eastern Delta sloughs and river reaches into which they drain.

In the Sacramento area, Morrison Creek's watershed covers approximately 150 square miles, and includes agricultural and mostly urban land uses. Morrison Creek flows into the Sacramento River downstream of the city of Freeport in the Northern Delta subarea. The hydrology and presence of diazinon and chlorpyrifos in Morrison Creek and other urban streams in the Sacramento area are discussed in detail in the Total Maximum Daily Load Report for the Pesticides Diazinon and Chlorpyrifos in: Arcade Creek, Elder Creek, Elk Grove Creek, Morrison Creek, and Chicken and Strong Ranch Sloughs, Sacramento County, California (Spector et al., 2004).

Treated wastewater and urban runoff are discharged from the Sacramento County Regional Wastewater Treatment Plant to the Sacramento River just south of the city of Freeport. The maximum flow from this facility is 181-million gallons per day (mgd), which is approximately equal to 250 cfs. Treated wastewater (and, occasionally, untreated wastewater during very intense storm events) and urban runoff are also discharged from the City of Sacramento's Combined Wastewater Collection and Treatment System into the Sacramento River at various points near the city of Sacramento.

The Cosumnes River is relatively small and flows for 80 miles from its headwaters in the Sierra Nevada to its junction with the Mokelumne River in the Delta. The Cosumnes River is the only undammed river on the western slope of the Sierra Nevada. The Cosumnes River receives drainage from agricultural and urban lands south of the city of Sacramento, and receives, via its tributary Deer Creek, treated wastewater from the cities of Elk Grove, El Dorado Hills and Cameron Park.

The lower Mokelumne River flows westward from Camanche Reservoir in the Sierra Foothills into the Delta, where it splits into the North and South Mokelumne Rivers, then comes back together and flows into the San Joaquin River. The Mokelumne River is fed by drainage from agricultural lands and urban lands near the city of Lodi.

Bear Creek flows southwestward into the Delta at Pixley Slough, draining areas to the south and southeast of Lodi. Just south of Bear Creek's watershed, Mosher Creek flows southwestward into the Delta at Mosher Slough, draining agricultural areas to the east of Stockton and urban lands in northern Stockton.

The lower Calaveras River flows westward from New Hogan Lake into the Delta, where it flows into the San Joaquin River. Water from the Calaveras River is at times diverted southward into Mormon Slough, which branches off of the Calaveras River in the foothills and travels westward into the Delta, where it joins the San Joaquin River. The combined Mormon Slough/Calaveras River watershed contains a significant amount of both agricultural and urban land near the city of Stockton. South of Mormon Slough, Duck Creek flows westward into the Delta at Walker Slough. Littlejohns Creek and Lone Tree Creek flow westward and join, forming French Camp Slough.

Eastern Delta waterbodies include (from north to south) Snodgrass Slough, the Cosumnes River, the Mokelumne River, Beaver Slough, Hog Slough, Sycamore Slough, White Slough, Bishop Cut, Disappointment Slough, the Calaveras River, Mormon Slough, and French Camp Slough. Figure E5 shows the Eastern Delta and Tributary subarea and the monitoring sites from which pesticide concentration data were obtained for this report.

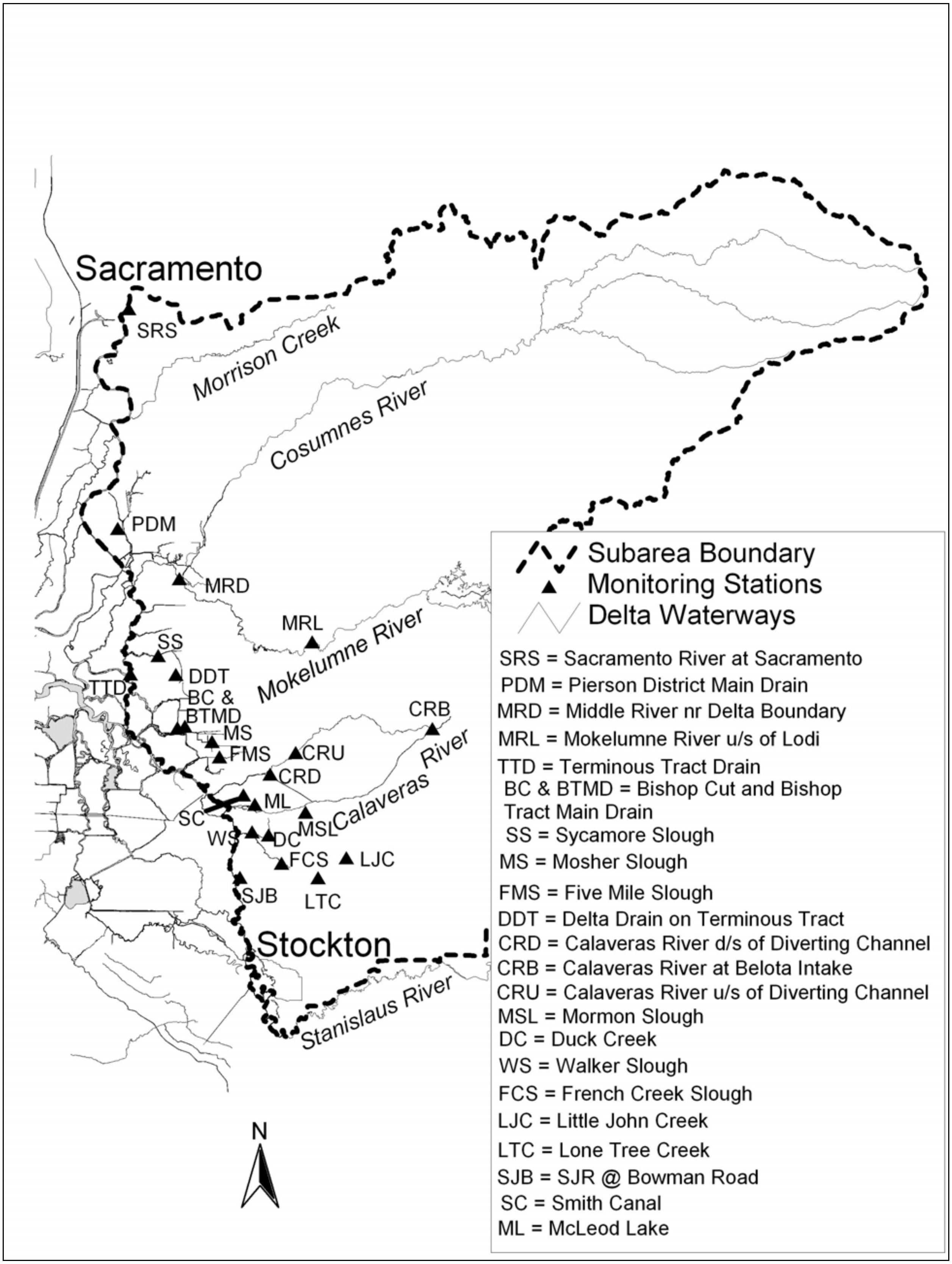

Figure E5. The Eastern Delta and Tributary Area

Diazinon and Chlorpyrifos Use in the Eastern Delta and Tributary Subarea

Agricultural diazinon use in the Eastern Delta and Tributary subarea averages approximately 18,000 pounds per year, based on use data from 1999-2003, with the main applications being to almond, cherry and apple orchards. Agricultural chlorpyrifos use in the Eastern Delta and Tributary Area averages approximately 49,000 pounds per year, based on use data from 1999-2003, with the main applications being to walnuts, alfalfa, almonds, corn and grapes. Apples and sugarbeets were also major chlorpyrifos uses in this subarea in the recent past. Urban use of both diazinon and chlorpyrifos was also likely high within this subarea in and around the cities of Stockton and Sacramento.

Diazinon and Chlorpyrifos in the Eastern Delta Waterways and Tributaries

Tables E11, E12 and E13 summarize available diazinon and chlorpyrifos data for the Eastern Delta and Tributary Area. The available data indicate that, where they enter the Delta, the Mokelumne and Calaveras Rivers occasionally contain chlorpyrifos and diazinon levels that exceed the proposed Water Quality Objectives. The smaller upland drainages flowing into the Delta from the east that receive urban and/or agricultural drainage also have occasional exceedances of the proposed Water Quality Objectives. The exceedances in these smaller upland drainages tend to be more frequent and with higher peak concentrations than in the Rivers in the Eastern Delta and Tributary Area. The smaller back sloughs within the Eastern Delta that receive urban and/or agricultural drainage also have measured exceedances of the proposed diazinon and chlorpyrifos Water Quality Objectives. The levels and frequency of exceedances in the small back sloughs appear to be greater than the exceedances in the rivers or the larger Delta sloughs where there is more dilution water available.

The upland drainages that receive urban runoff in the Sacramento area, such as Morrison, Elder and Elk Grove creeks, have been shown to have elevated diazinon and chlorpyrifos concentrations, especially following rainfall events (Karkoski et al., 2004). Similarly, back sloughs and small upland drainages receiving urban runoff in the Stockton Area have been shown to have elevated diazinon and chlorpyrifos concentrations, especially following rainfall events (Bailey, et al., 2000).

Further downstream, the San Joaquin River near the city of Stockton also has diazinon at levels that occasionally exceed the proposed Water Quality Objectives, but there have been no measured exceedances for chlorpyrifos. No chlorpyrifos or diazinon data are available for the Cosumnes River, Bear Creek, Snodgrass Slough, Beaver Slough, Hog Slough, Sycamore Slough, White Slough, or Disappointment Slough.

Table E11. Diazinon Concentrations for the Eastern Delta and Tributary Area

Location	# of Samples	Median Conc. (ng/L)	90th Percentile Conc. (ng/L)	Maximum Conc. (ng/L)	# of Samples >160 ng/L	% of Samples > 160 ng/L
Mokelumne River near Delta Boundary	44	0	19	230	1	2%
Mokelumne River u/s of Lodi	4	0	0	0	0	0%
Sycamore Slough	1	0	0	0	0	0%
Delta Drain on Terminous Tract	4	0	11	16	0	0%
Bishop Cut	1	10	10	10	0	0%
Mosher Slough	77	130	547	1,400	31	40%
Five-Mile Slough	62	58	304	734	16	26%
Calaveras River at Belota Intake	2	0	0	0	0	0%
Calaveras River d/s Stockton Diverting Channel	43	43	308	1,700	10	23%
Smith Canal	1	129	129	129	0	0%
Mormon Slough	1	404	404	404	1	100%
Duck Creek	6	48	1,025	1,900	1	17%
McLeod Lake	4	0	14	20	0	0%
Pierson District Main Drain	1	0	0	0	0	0%
SJR at Bowman Rd	3	400	490	513	2	67%
SJR nr Stockton	50	80	258	797	15	30%
Littlejohns Creek	4	0	0	0	0	0%
Lone Tree Creek	9	120	1,390	2,790	4	44%
Walker Slough	6	0	85	170	1	17%
French Camp Slough	59	9	202	1,110	7	12%

Table E12. Chlorpyrifos Concentrations In the Eastern Delta and Tributary Area

Location	# of Samples	Median Conc. (ng/L)	90th Percentile Conc. (ng/L)	Maximum Conc. (ng/L)	# of Samples > 25 ng/L	% of Samples > 25 ng/L
Mokelumne River near Delta Boundary	42	0	0	43	2	5%
Mokelumne River u/s of Lodi	4	0	0	0	0	0%
Sycamore Slough	1	0	0	0	0	0%
Delta Drain on Terminous Tract	4	0	0	0	0	0%
Bishop Cut	1	10	10	10	0	0%
Mosher Slough	72	7	107	210	23	32%
Five-Mile Slough	61	0	49	104	11	18%
Calaveras River at Belota Intake	2	0	0	0	0	0%
Calaveras River ds Stockton Diverting Channel	43	0	53	110	6	14%
Calaveras River u/s SDC	2	117	130	133	2	100%
Smith Canal	1	46	46	46	1	100%
Duck Creek	6	22	105	120	3	50%
McLeod Lake	4	0	0	0	0	0%
Pierson District Main Drain	1	0	0	0	0	0%
SJR at Bowman Rd	3	0	8	10	0	0%
SJR at Buckley Cove	12	0	0	0	0	0%
SJR nr Stockton	50	0	0	16	0	0%
Littlejohns Creek	4	0	0	0	0	0%
Lone Tree Creek	9	0	3	14	0	0%
Walker Slough	5	0	30	35	1	20%
French Camp Slough	60	5	65	520	9	15%

Table E13. Combined Criteria-Normalized Diazinon and Chlorpyrifos Data for the Eastern Delta and Tributary Area

Location	# of Samples	Median S[1] Value	90th Percentile S Value	Maximum S value	# of Samples S > 1	% of Samples S > 1
Mokelumne River near Delta Boundary	42	0.0	0.1	2.1	2	5%
Mokelumne River u/s of Lodi	4	0.0	0.0	0.0	0	0%
Sycamore Slough	1	0.0	0.0	0.0	0	0%
Delta Drain on Terminous Tract	4	0.0	0.1	0.1	0	0%
Bishop Cut	1	0.5	0.5	0.5	0	0%
Mosher Slough	63	0.9	7.3	17.1	31	49%
Five-Mile Slough	57	0.3	3.5	6.4	17	30%
Calaveras River at Belota Intake	2	0.0	0.0	0.0	0	0%
Calaveras River ds Stockton Diverting Channel	43	0.6	2.7	14.6	15	35%
Smith Canal	1	2.6	2.6	2.6	1	100%
Duck Creek	6	1.2	10.6	16.7	3	50%
McLeod Lake	4	0.0	0.1	0.1	0	0%
Pierson District Main Drain	1	0.0	0.0	0.0	0	0%
SJR at Bowman Rd	3	2.5	3.4	3.6	2	67%
SJR nr Stockton	50	0.6	1.6	5.0	15	30%
Littlejohns Creek	4	0.0	0.0	0.0	0	0%
Lone Tree Creek	9	1.1	8.7	17.4	5	56%
Walker Slough	5	0.0	1.2	1.4	1	20%
French Camp Slough	58	0.5	3.4	21.0	17	29%

[1] S = the sum of the criteria-normalized diazinon and chlorpyrifos concentrations as defined by Equation 1 in Section 2.3.3 of the main report.

Southern Delta and Tributary Subarea

The Southern Delta and Tributary subarea encompasses the southern part of the Legal Delta and the lands that flow into the Southern Delta from the southwest. The Southern Delta and Tributary subarea's northern boundary is north of Clifton Court Forebay, Victoria Canal, and Trapper Slough extending as far east as the intersection of Old River and Burns Cutoff near Stockton. Its eastern boundary is east of the San Joaquin River, extending as far south as the San Joaquin River near Vernalis (the southern boundary of the Legal Delta). Its southwestern boundary extends from the western end of Clifton Court Forebay southeast to include all the tributary areas to the southwest of the Southern Delta.

The surface water in the Southern Delta and Tributary subarea is dominated by water from the San Joaquin River, the second largest Delta Tributary, but also contains local flows from irrigation and rainfall on Delta islands and upland areas, outflow from the Eastern Delta and Tributary subarea, and occasionally water from the Central Delta via tidal and export pumping-induced flows. The San Joaquin River enters the Delta from the south near the community of Vernalis. Unlike the Sacramento River, most of which flows through the Delta into San Francisco Bay during the entire year, the San Joaquin River's water flows through multiple channels, and is often diverted to the State Water Project (SWP) and Central Valley Project (CVP) pumps in the southern Delta near Clifton Court Forebay. Old River connects the San Joaquin River to Clifton Court Forebay. Paradise Cut and Tom Paine Slough connect the San Joaquin River to Old River. Grant Line Canal connects Old River to Clifton Court Forebay. There are a number of direct agricultural discharges where drainage is pumped from Delta islands into the San Joaquin River, Old River, Paradise Cut, Grant Line Canal and other Delta Waterways in the Southern Delta (DWR, 1995). The water in the area in and around Clifton Court Forebay is mostly Sacramento River water that is re-directed through the Central Delta towards the SWP and CVP export pumps. Figure E6 shows the Southern Delta and Tributary subarea and the monitoring sites from which pesticide concentration data were obtained for this report.

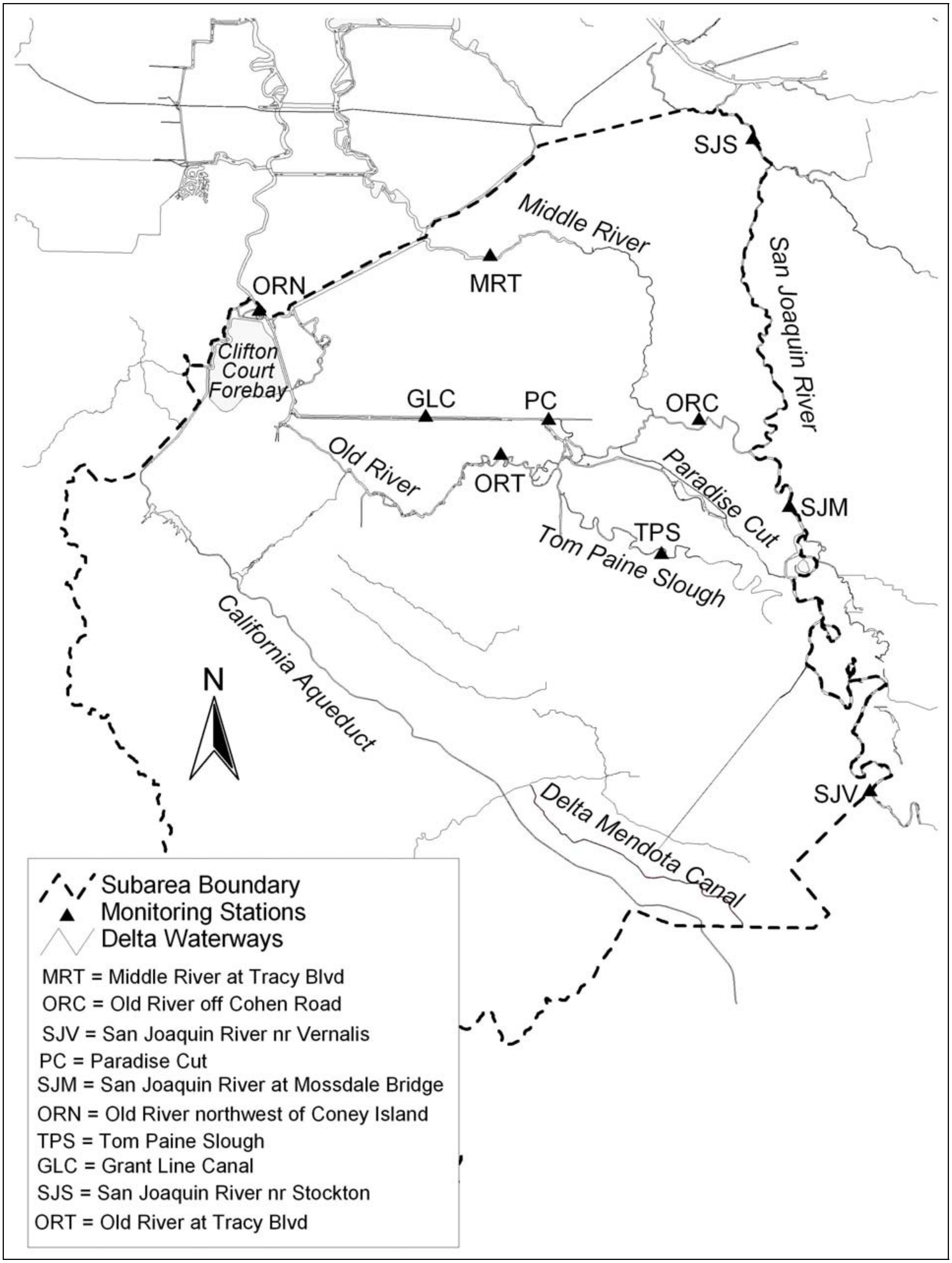

Figure E6. The Southern Delta and Tributary Subarea

Diazinon and Chlorpyrifos Use in the Southern Delta and Tributary Area

Agricultural diazinon use in the Southern Delta and Tributary Area averages approximately 2,000 pounds per year, based on use data from 1999-2003, with the only major use being applications to tomatoes. Agricultural chlorpyrifos use in the Southern Delta and Tributary Area averages approximately 12,000 pounds per year, based on use data from 1999-2003 with the major use being application to alfalfa, and a relatively minor use on walnut orchards.

Diazinon and Chlorpyrifos in the Southern Delta Waterways and Tributaries

Tables E14, E15 and E16 summarize available diazinon and chlorpyrifos data for the Southern Delta and Tributary Area. Over 1,000 samples have been collected from the San Joaquin River at where it flows into the Legal Delta near Vernalis. Many of those samples contained diazinon and chlorpyrifos concentrations that exceed the proposed Water Quality Objectives. Like diazinon concentrations in the Sacramento River at Sacramento, diazinon concentrations in the San Joaquin River at Vernalis are highest in January and February. Unlike the Sacramento River at Sacramento, however, diazinon concentrations in the San Joaquin River at Vernalis have exceeded the proposed Water Quality Objectives during the non-dormant season as well. Exceedances of the proposed diazinon Water Quality Objectives were observed in the Old River and in Grant Line Canal. Exceedances of the proposed chlorpyrifos Water Quality Objectives were also observed in the Old River, Grant Line Canal and Paradise Cut. Few data points are available for many of the other Delta Waterways in the Southern Delta.

Table E14. Diazinon Concentrations for the Southern Delta and Tributary Area

Location	# of Samples	Median Conc. (ng/L)	90th Percentile Conc. (ng/L)	Maximum Conc. (ng/L)	# of Samples >160 ng/L	% of Samples > 160 ng/L
Middle River at Tracy Blvd	4	0	0	0	0	0%
Old River at Tracy Rd	33	0	16	38	0	0%
Old River off Cohen Road	2	229	331	357	1	50%
Old River Northwest of Coney Island	5	0	0	0	0	0%
Grant Line Canal	21	88	241	688	5	24%
Paradise Cut	36	0	25	125	0	0%
SJR nr Vernalis	1,237	4	93	1,216	72	6%
Tom Paine Slough	5	0	0	0	0	0%

Table E15. Chlorpyrifos Concentrations in the Southern Delta and Tributary Area

Location	# of Samples	Median Conc. (ng/L)	90th Percentile Conc. (ng/L)	Maximum Conc. (ng/L)	# of Samples > 25 ng/L	% of Samples > 25 ng/L
Middle River at Tracy Blvd	4	12	14	14	0	0%
Old River at Tracy Rd	33	0	8	37	1	3%
Old River off Cohen Road	2	0	0	0	0	0%
Old River northwest of Coney Island	5	0	0	0	0	0%
Grant Line Canal	21	0	15	76	1	5%
Paradise Cut	39	0	93	550	6	15%
SJR at Mossdale Bridge	12	0	0	0	0	0%
SJR nr Vernalis	1,185	0	9	110	19	2%
Tom Paine Slough	5	0	0	0	0	0%

Table E16. Combined Criteria-Normalized Diazinon and Chlorpyrifos Concentrations in the Southern Delta and Tributary Area

Location	# of Samples	Median S[1] Value	90th Percentile S Value	Maximum S value	# of Samples S > 1	% of Samples S > 1
Middle River at Tracy Blvd	4	0.5	0.6	0.6	0	0%
Old River at Tracy Rd	33	0.0	0.4	1.5	1	3%
Old River off Cohen Road	2	1.4	2.1	2.2	1	50%
Old River Northwest of Coney Island	5	0.0	0.0	0.0	0	0%
Grant Line Canal	21	0.8	1.6	4.3	6	29%
Paradise Cut	36	0.1	4.9	22.3	6	17%
SJR nr Vernalis	1089	0.1	1.0	9.1	105	10%
Tom Paine Slough	5	0.0	0.0	0.0	0	0%

[1] S = the sum of the criteria-normalized diazinon and chlorpyrifos concentrations as defined by Equation 1 in Section 2.3.3 of the main report.

Central Delta and Tributary Subarea

The Central Delta and Tributary Subarea contains the area bound by the other Delta subareas, and extends into the uplands southwest of the Legal Delta to contain all the lands draining into the Central Delta from the southwest. The sources of surface water in the Central Delta and Tributary subarea are a mix of water from the Northern Delta, Southern Delta, Eastern Delta, and the Western Delta subareas, as well as local runoff and discharges.

The waters from all of the Delta tributaries come together within the central Delta. The San Joaquin River flows through the center of the Delta. Georgiana Slough and the Delta Cross Channel connect the Sacramento River to the Mokelumne River. The North and Middle Forks of the Lower Mokelumne River flow into the San Joaquin River from the northwest, sometimes carrying Sacramento River water that is diverted into the Mokelumne River through the Delta Cross Channel. The Old and Middle rivers are connected to the San Joaquin River from the south. There are several additional interconnected sloughs, canals, and cuts within the Central Delta. Depending on the tides, the amount of flow in the rivers, and the amount of pumping at the SWP and CVP export pumps, the waters in the San Joaquin River, Old River and Middle River can change directions and flow towards the pumps instead of towards San Francisco Bay. There are dozens of direct agricultural discharges from Central Delta islands that are pumped over levees into the Delta Waterways. Figure E7 shows the Central Delta and Tributary subarea, including the monitoring sites from which pesticide concentration data were obtained for this report.

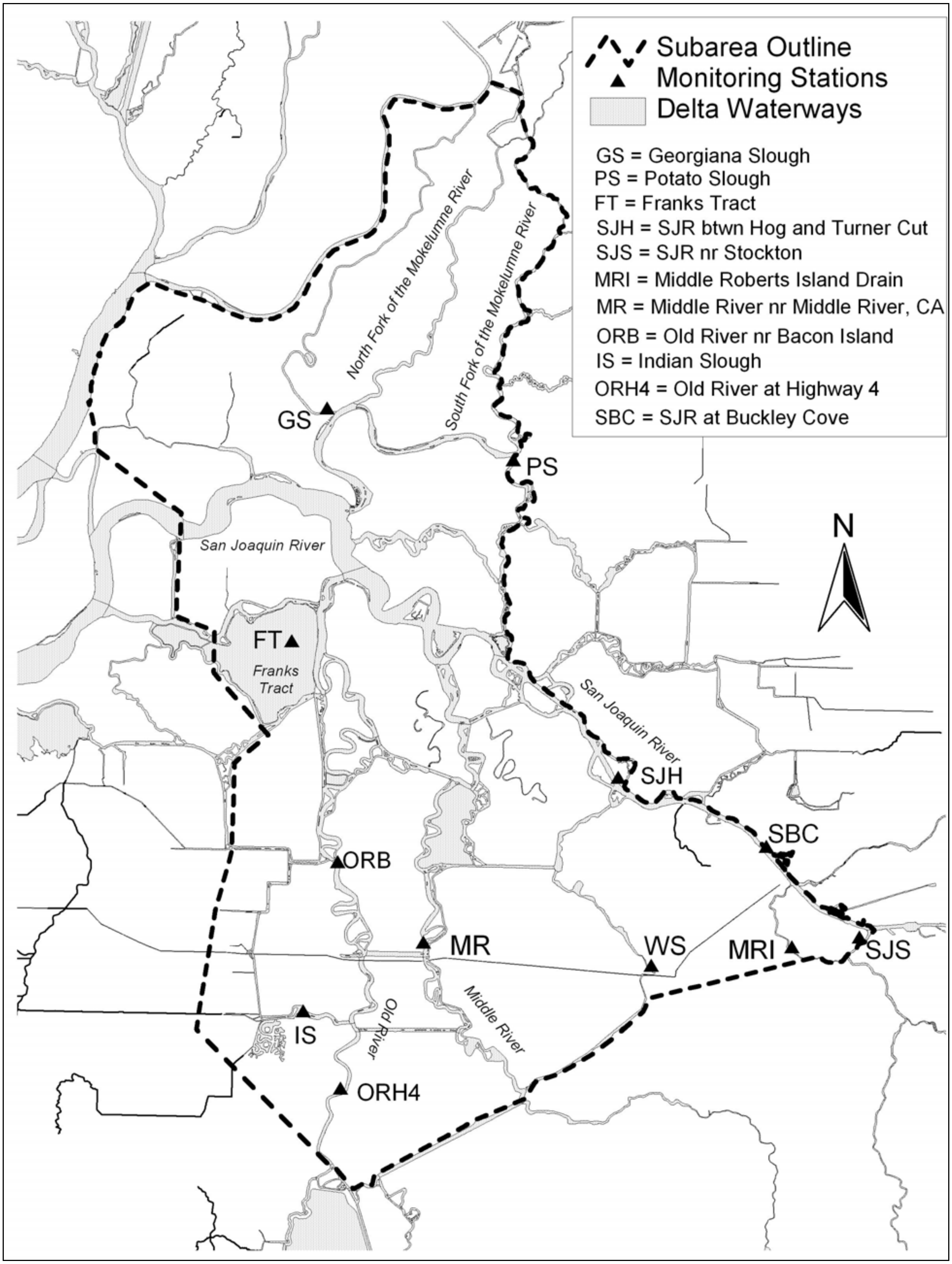

Figure E7. The Central Delta

Diazinon and Chlorpyrifos Use in Central Delta and Tributary Subarea

Agricultural diazinon use in the Central Delta and Tributary area is much less than all the other subareas, averaging approximately 350 pounds per year based on use data from 1999-2003, with the main uses being pears and tomatoes. Agricultural chlorpyrifos use in the Central Delta and Tributary Area averages approximately 3,500 pounds per year, based on use data from 1999-2003 with the main uses being asparagus and alfalfa.

Diazinon and Chlorpyrifos in Central Delta and Tributary Subarea

Tables E17, E18, and E19 summarize available diazinon and chlorpyrifos surface water concnentraion data for the Central Delta and Tributary subarea. With the exception of the San Joaquin River, no exceedances of the proposed Water Quality Objectives were measured within the Central Delta Waterways. This may be partially due to the large tidal flows from the west diluting pesticide concentrations in Central Delta. Unlike in other Central Valley rivers, following winter storms, well-defined diazinon pulses are not observed in the Old and Middle rivers in the Central Delta. This may be due to the mixing of multiple riverine sources of pesticides and the hydrologic complexity of the Central Delta. In January and February of 1993, the Old and Middle river's diazinon concentrations appeared to steadily increase, reaching maximum concentrations of 149 and 121 ng/L for the Old and Middle rivers, respectively (Kuivila and Foe, 1995). The water entering the Delta from Middle Roberts Island Drain (which is a considered to be a Delta island drain, and not a Delta Waterway) exceeded the proposed Water Quality Objectives for chlorpyrifos, but not diazinon. The data for the San Joaquin River near the city of Stockton indicate exceedances of the proposed Water Quality Objective for diazinon but there were no measured exceedances of the proposed Water Quality Objective for chlorpyrifos.

Table E17. Diazinon Concentrations in the Central Delta

Location	# of Samples	Median Conc. (ng/L)	90th Percentile Conc. (ng/L)	Maximum Conc. (ng/L)	# of Samples >160 ng/L	% of Samples > 160 ng/L
Frank's Tract	4	0	0	0	0	0%
Georgiana Slough	6	0	0	0	0	0%
Indian Slough	7	17	26	30	0	0%
Middle River near Middle River	57	56	129	149	0	0%
Middle Roberts Island Drain	45	0	15	82	0	0%
Old River nr Bacon Island	35	38	93	121	0	0%
Potato Slough	4	0	0	0	0	0%
SJR btwn Hog and Turner Cut	5	0	0	0	0	0%
SJR nr Stockton	50	80	258	797	15	30%
Terminous Tract Drain	2	13	23	25	0	0%
Whiskey Slough	5	0	0	0	0	0%

Table E18. Chlorpyrifos Concentrations in the Central Delta

Location	# of Samples	Median Conc. (ng/L)	90th Percentile Conc. (ng/L)	Maximum Conc. (ng/L)	# of Samples > 25 ng/L	% of Samples > 25 ng/L
Frank's Tract	16	0	0	0	0	0%
Georgiana Slough	6	0	0	0	0	0%
Indian Slough	7	0	9	22	0	0%
Middle River near Middle River	57	0	0	4	0	0%
Middle Roberts Island Drain	45	9	56	360	11	24%
Old River nr Bacon Island	47	0	0	3	0	0%
Potato Slough	4	0	0	0	0	0%
SJR btwn Hog and Turner Cut	5	0	0	0	0	0%
SJR nr Stockton	50	0	0	16	0	0%
Terminous Tract Drain	2	6	11	12	0	0%
Whiskey Slough	5	0	0	0	0	0%

Table E19. Combined Criteria-Normalized Diazinon and Chlorpyrifos Concentrations in the Central Delta

Location	# of Samples	Median S[1] Value	90th Percentile S Value	Maximum S value	# of Samples S > 1	% of Samples S > 1
Georgiana Slough	6	0.0	0.0	0.0	0	0%
Indian Slough	7	0.1	0.5	1.0	0	0%
Middle River near Middle River	65	0.4	0.8	0.9	0	0%
Middle Roberts Island Drain	45	0.4	2.2	14.4	11	24%
Old River nr Bacon Island	35	0.2	0.6	0.8	0	0%
Potato Slough	4	0.0	0.0	0.0	0	0%
SJR btwn Hog and Turner Cut	5	0.0	0.0	0.0	0	0%
SJR nr Stockton	50	0.6	1.6	5.0	15	30%
Terminous Tract Drain	2	0.3	0.4	0.5	0	0%
Whiskey Slough	5	0.0	0.0	0.0	0	0%

[1] S = the sum of the criteria-normalized diazinon and chlorpyrifos concentrations as defined by Equation 1 in Section 2.3.3 of the main report.

Western Delta and Tributary Subarea

The Western Delta and Tributary subarea encompasses the westernmost side of the Delta within the Central Valley Region, and the upland areas that drain to this part of the Delta from the north and south. The sources of surface water in the Western Delta and Tributary subarea are a mix of water from tidal flows from San Francisco Bay in the San Francisco Bay Region, outward flows from the Northern, Central and Southern Delta subareas, and local irrigation and rainfall runoff. The voluminous tidal flows from San Francisco Bay provide significant dilution in the main channels of the Western Delta. The Western Delta and Tributary subarea’s western boundary is the boundary between the Central Valley Region and the San Francisco Bay Region and its eastern boundary begins just west of Rio Vista and extends south past the western extents of Sevenmile Slough and Frank’s Tract to the intersection of Rock Slough and Sand Mound Slough. Its northern and southern boundaries are defined by the Northwestern Delta and Tributary subarea and the Southern Delta and Tributary subarea.

The Sacramento and San Joaquin Rivers merge in the western Delta, where the Delta flows into Suisun Bay. The average tidal ebb or flood at Chipps Island is 170,000 cfs, while the average net Delta outflows are 32,000 and 6,000 cfs for winter and summer, respectively (DWR, 1995). The tidal flows from San Francisco Bay likely serve to dilute the concentrations of pesticides from the Central Valley. As with the other areas of the Delta, there are several direct agricultural discharges from western Delta islands that are pumped over levees into the Delta Waterways. Kellogg Creek, Marsh Creek, and a number of other small creeks flow into the Delta from the southwest. These creeks pass through agricultural and urban areas as they approach the Delta. Marsh Creek flows through the communities of Brentwood and Oakley and into the Delta at Big Break. Figure E8 shows the Western Delta and Tributary subarea and the monitoring sites from which pesticide concentration data were obtained for this report.

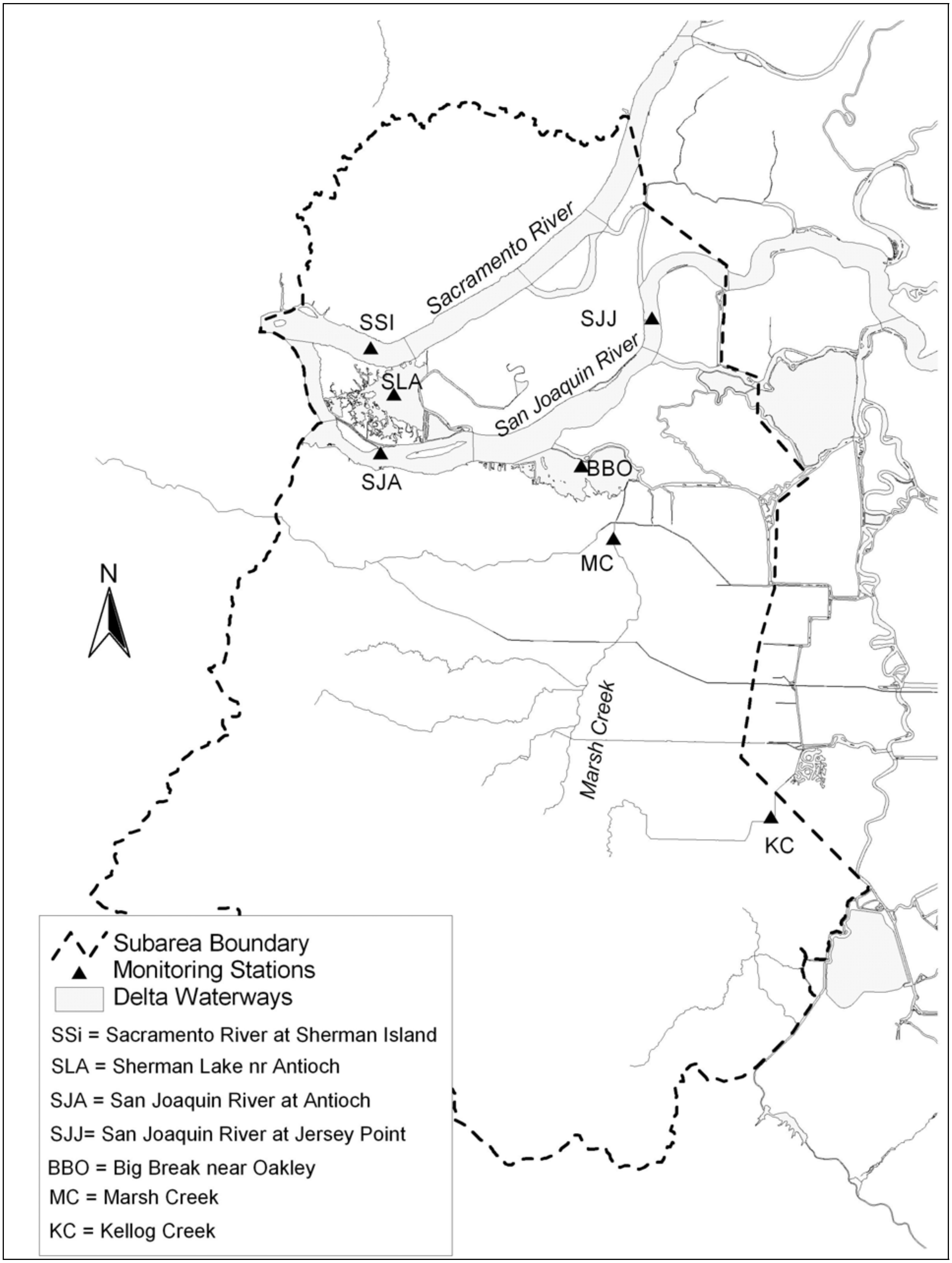

Figure E8. The Western Delta and Tributary Area.

Diazinon and Chlorpyrifos Use in the Western Delta and Tributary Area

Agricultural diazinon use in the Western Delta and Tributary Area averages approximately 1,600 pounds per year, based on use data from 1999-2003, with the main applications being to apple orchards. Agricultural chlorpyrifos use in the Western Delta and Tributary Area is much less than the use in any of the other Delta subareas, averaging approximately 500 pounds per year, based on use data from 1999-2003 with the main use being applications to corn fields.

Diazinon and Chlorpyrifos in Western Delta Waterways and Tributaries

Table E20 summarizes available diazinon and chlorpyrifos surface water concentration data in the Western Delta and Tributary subarea. As was the case in the Central Delta, exceedances of the proposed Water Quality Objectives were less common and of a lesser magnitude in the main Delta Waterways of the Western Delta when compared to the upstream areas such as the Northern, Eastern or Southern Delta subareas. This may be partially due to the large tidal flows from the west diluting pesticide concentrations in Western Delta.

Diazinon concentrations above the proposed Water Quality Objectives for diazinon have been observed in the Delta outflow near Chipps Island during a winter storm runoff event in February of 1993, when pulses of diazinon from the Sacramento River were traced across the Delta as far west as the delta outflow into Suisun Bay near Chipps Island (Kuivila and Foe, 1995). As with the rest of the Sacramento River, which is the main source of the Delta water as it flows into Suisun Bay, diazinon concentrations are highest in January and February in the Western Delta. Using data from samples collected infrequently (3 times per year from 1993-1998) at the Sacramento and San Joaquin rivers near their outlets, Davis and others (2000) estimated the annual diazinon and chlorpyrifos loads entering the San Francisco Bay from the Delta to be 1,100 kg/year and 28 kg/year, respectively. This was a rough estimate that did not characterize storm-event loads, so the actual annual loads are likely higher (Davis et al., 2000). Diazinon and chlorpyrifos concentrations above the proposed Water Quality Objectives were also observed in Kellogg and Marsh creeks.

Table E20. Diazinon and Chlorpyrifos Concentrations in the Western Delta and Tributary Subarea

Diazinon						
Location	**# of Samples**	**Median Conc. (ng/L)**	**90th Percentile Conc. (ng/L)**	**Max Conc. (ng/L)**	**# of Samples >160 ng/L**	**% of Samples > 160 ng/L**
Kellogg Creek	1	0	0	0	0	0%
Marsh Creek	52	19	99	380	3	6%
SJR at Jersey Point	5	0	0	0	0	0%
SJR at Antioch	18	2	27	35	0	0%
Sac R nr Sherman Island	16	3	18	38	0	0%
Delta Outflow at Chipps Island	35	40	150	199	3	9%
Chlorpyrifos						
Location	**# of Samples**	**Median Conc. (ng/L)**	**90th Percentile Conc. (ng/L)**	**Max Conc. (ng/L)**	**# of Samples > 25 ng/L**	**% of Samples > 25 ng/L**
Sherman Lake near Antioch	12	0	0	0	0	0%
Kellogg Creek	1	180	180	180	1	100%
Marsh Creek	52	0	8	24	0	0%
Big Break near Oakley	11	0	0	0	0	0%
SJR at Jersey Point	5	0	0	0	0	0%
SJR at Antioch	29	0	0	1	0	0%
Sac R nr Sherman Island	28	0	0	1	0	0%
Delta Outflow at Chipps Island	35	0	0	0	0	0%
Combined Criteria-Normalized Diazinon and Chlorpyrifos						
Location	**# of Samples**	**Median S[1] Value**	**90th Percentile S Value**	**Maximum S value**	**# of Samples S > 1**	**% of Samples S > 1**
Kellogg Creek	1	7.2	7.2	7.2	1	100%
Marsh Creek	52	0.1	1.0	2.7	4	8%
SJR at Jersey Point	5	0.0	0.0	0.0	0	0%
SJR at Antioch	16	0.0	0.2	0.2	0	0%
Sac R nr Sherman Island	15	0.0	0.1	0.2	0	0%
Delta Outflow at Chipps Island	35	0.25	0.94	1.24	3	9%

[1] S = the sum of the criteria-normalized diazinon and chlorpyrifos concentrations as defined by Equation 1.

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CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL VALLEY REGION

Amendments to the Water Quality Control Plan For the Sacramento River and San Joaquin River Basins

For

The Control of Diazinon and Chlorpyrifos Runoff into the Sacramento-San Joaquin Delta

Appendix F

Maps of Total Annual Agricultural Diazinon and Chlorpyrifos Applications in the Delta Watershed 1999-2003, by Year

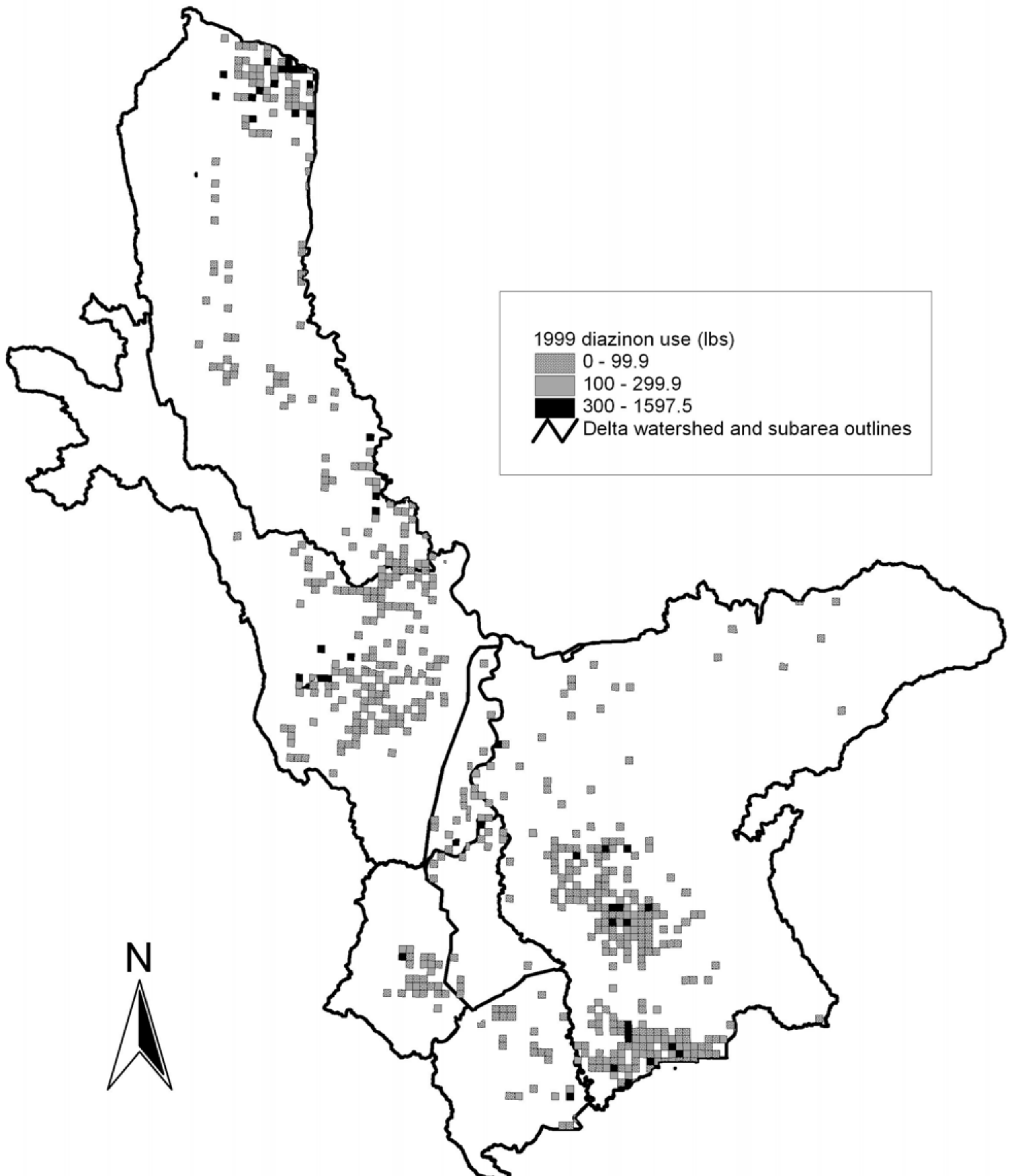
January, 2006 Peer Review Draft

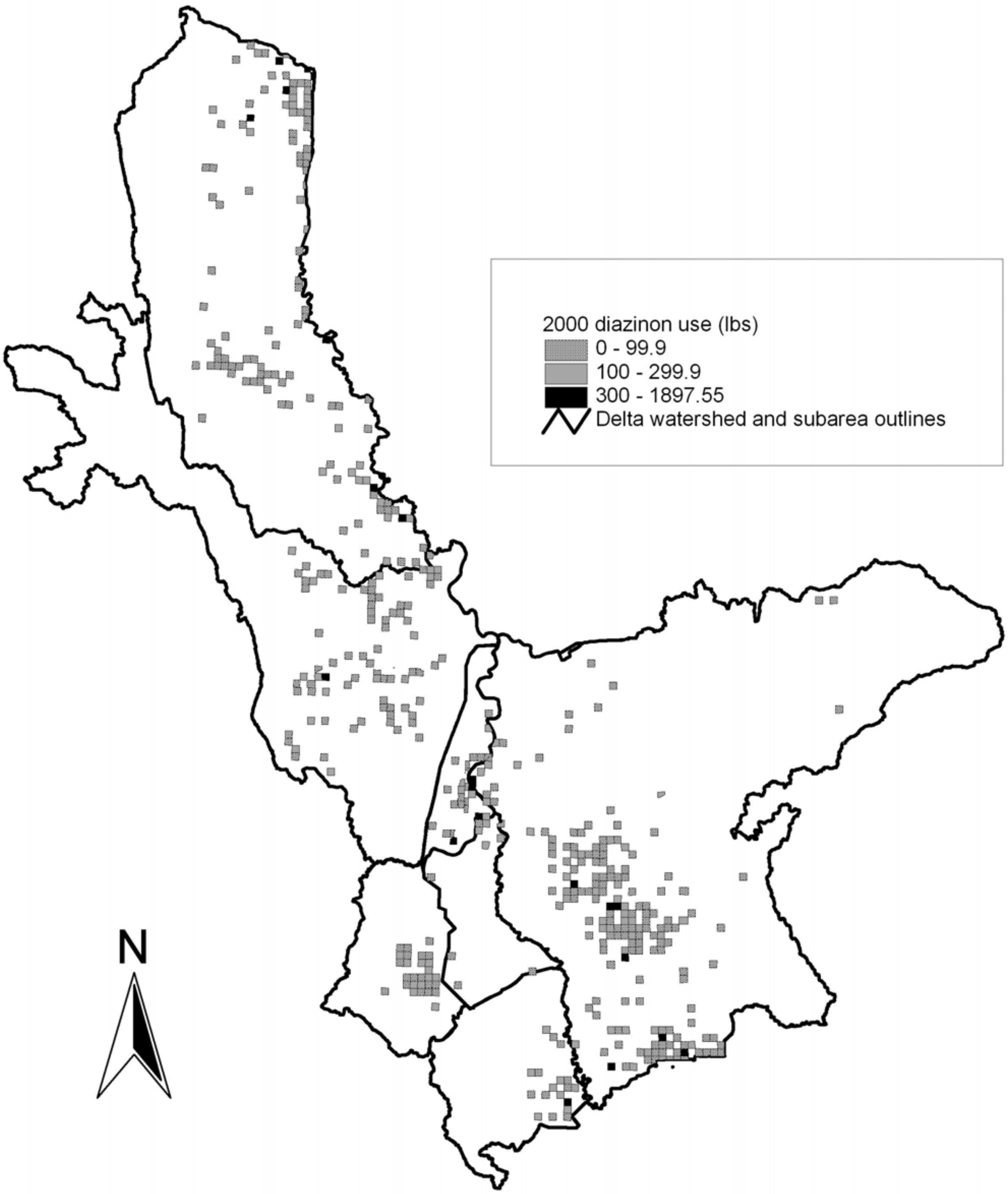
Description

The following figures show the locations of agricultural diazinon and chlorpyrifos applications within the Delta watershed for 1999 through 2003 as reported in DPR's Pesticide Use Report database (DPR, 2005). The outlines of the seven Delta subareas described in Appendix E ar e included to provide geographical reference. The shaded squares showing application amounts each represent an area of one square mile.

References

DPR. 2005. Pesticide Use Report Database. California Department of Pesticide Regulations (DPR). Sacramento, CA.


1999 diazinon use (lbs)
0 - 99.9
100 - 299.9
300 - 1597.5
Delta watershed and subarea outlines
N



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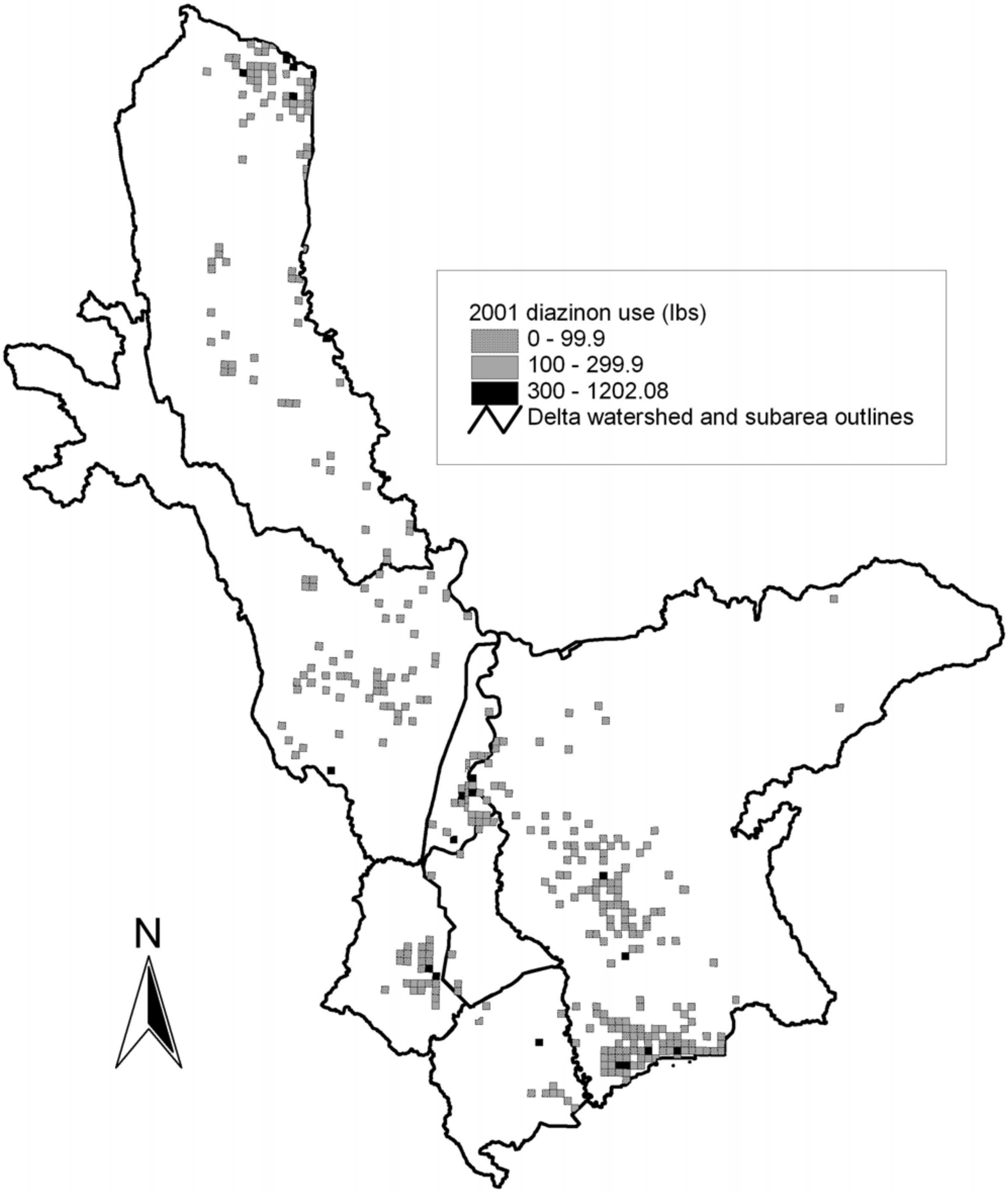
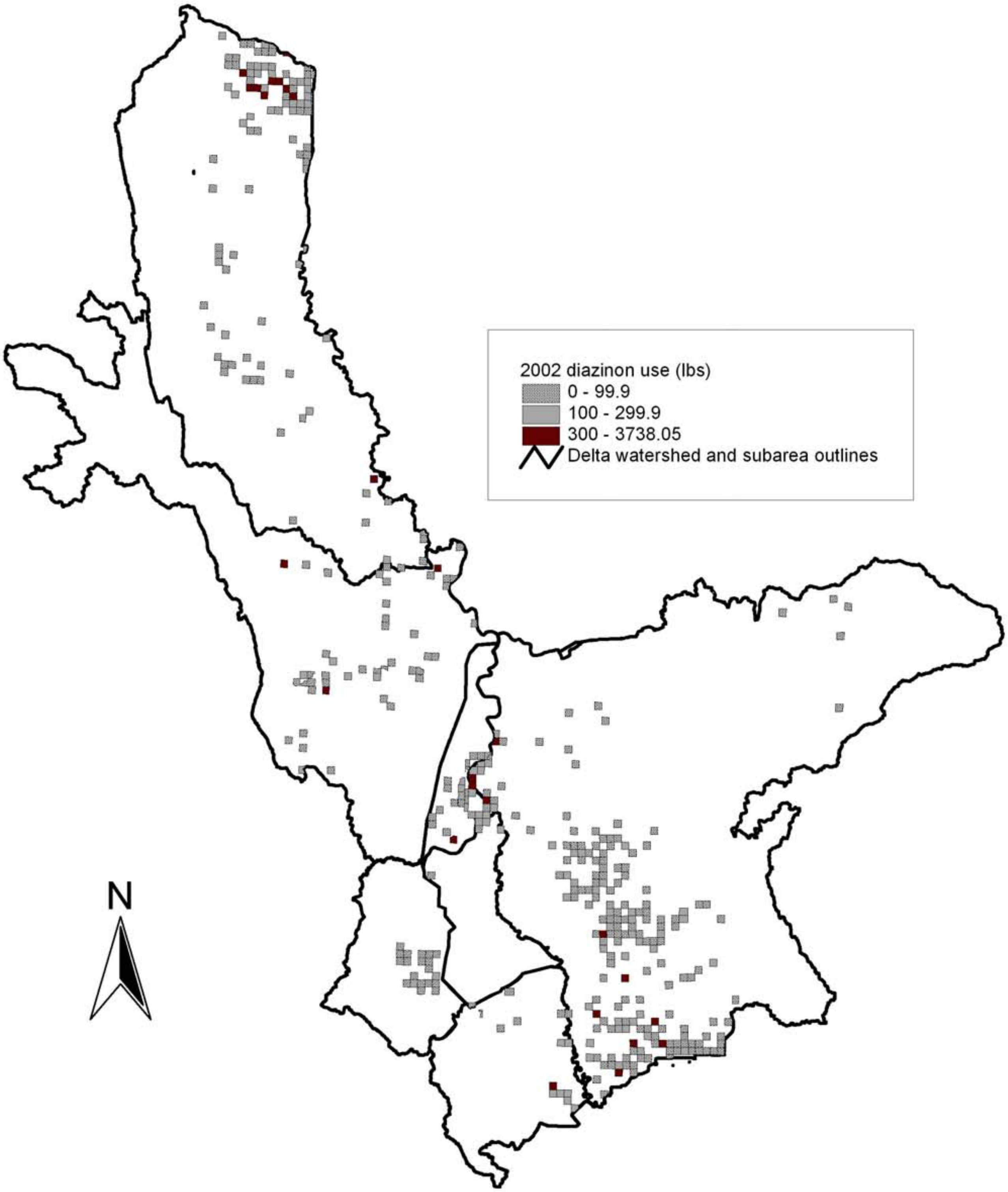
0 - 99.9
100 - 299.9
300 - 1897.55
Delta watershed and subarea outlines
N


2001 diazinon use (lbs)
0 - 99.9
100 - 299.9
300 - 1202.08
Delta watershed and subarea outlines
N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100 - 299.9
300 - 3738.05
Delta watershed and subarea outlines
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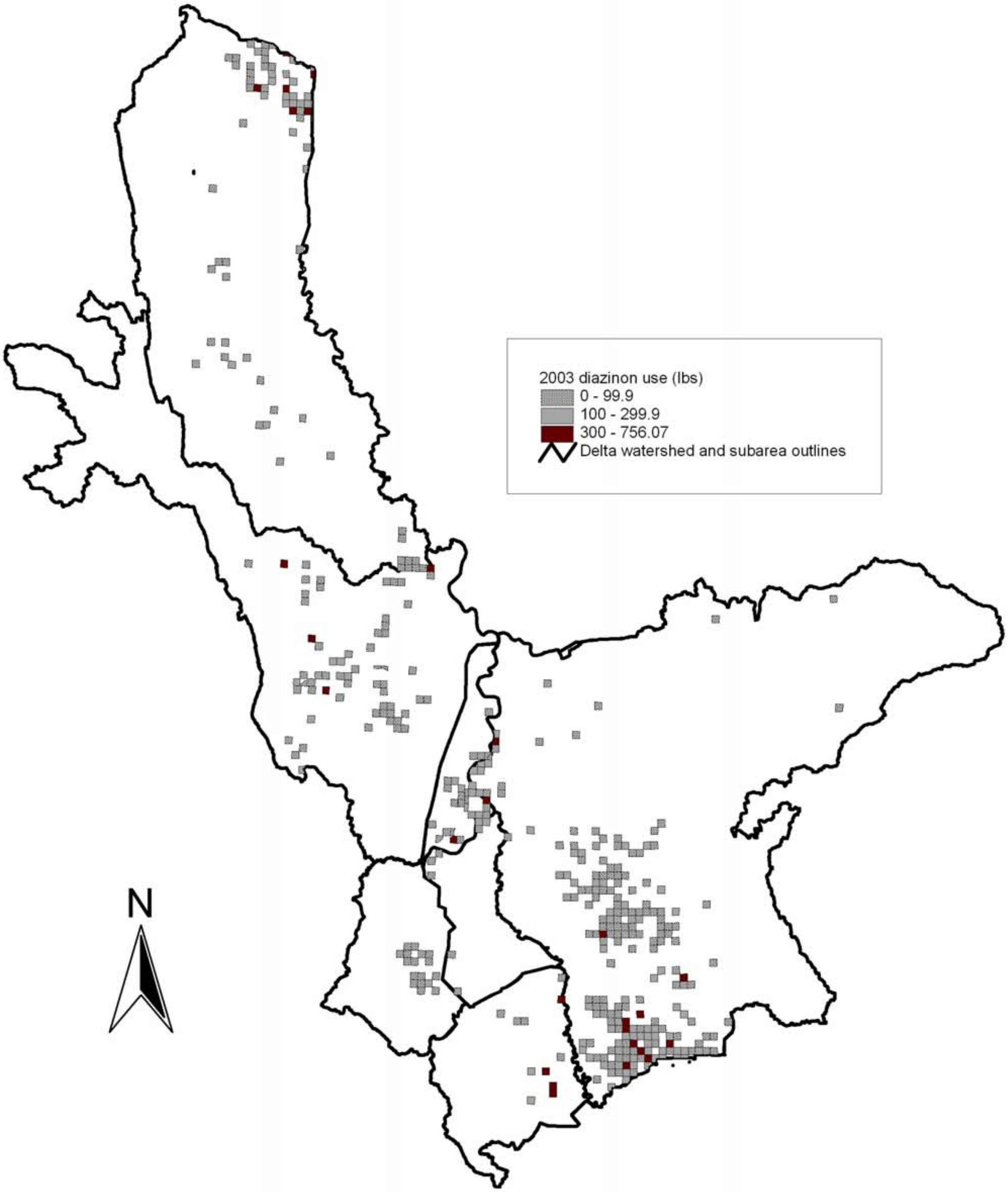
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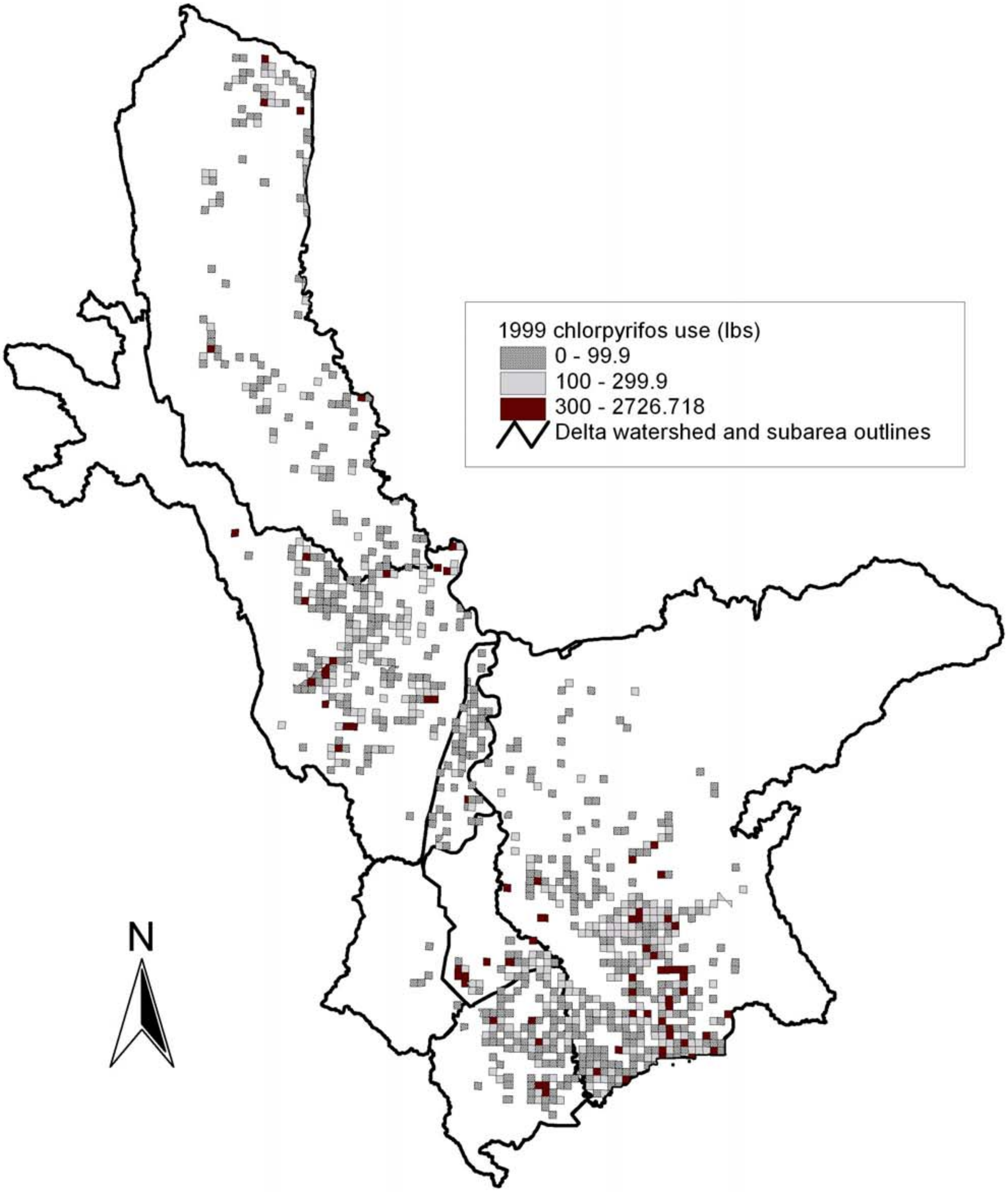
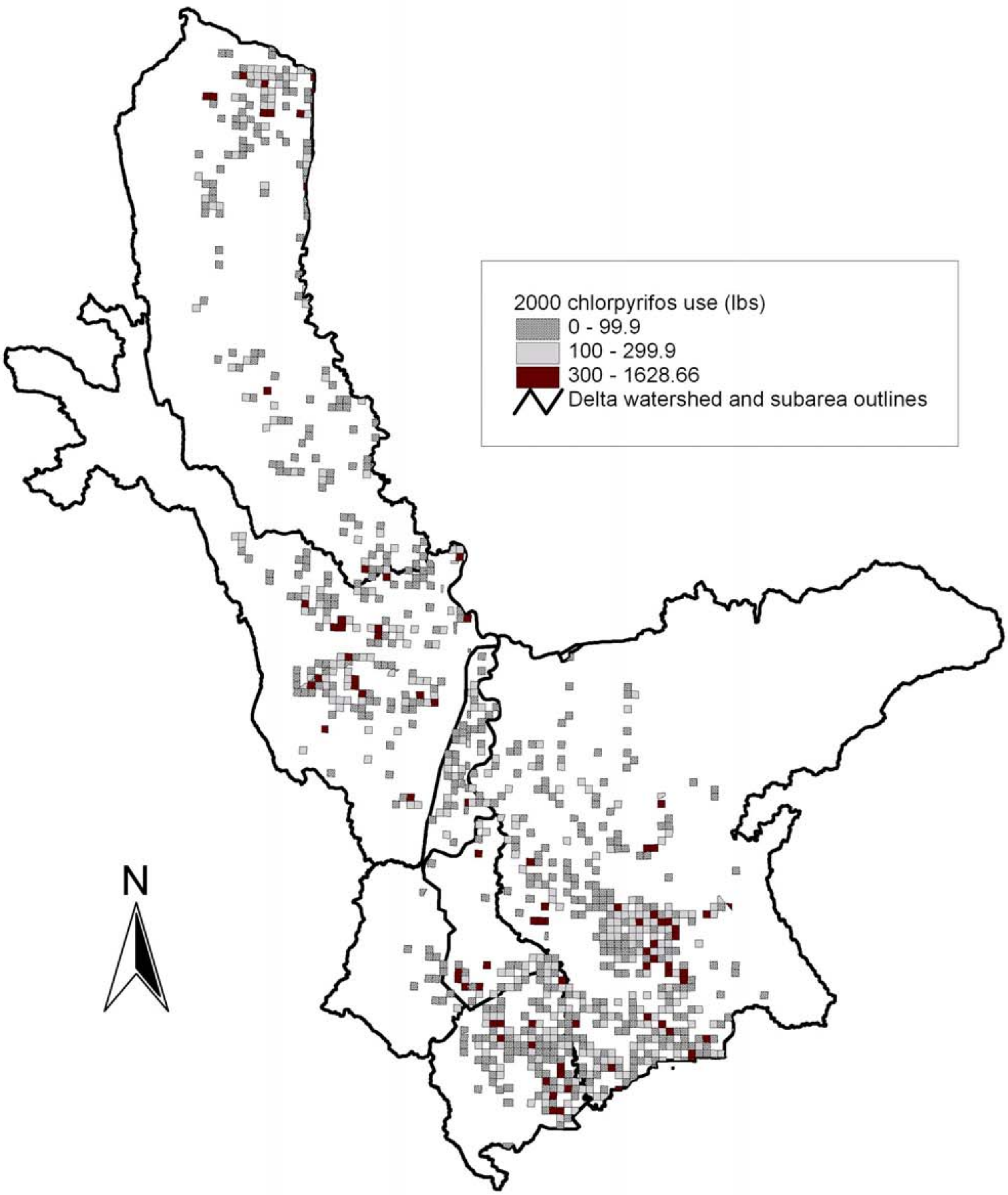
100 - 299.9
300 - 756.07
Delta watershed and subarea outlines
N


1999 chlorpyrifos use (lbs)
0 - 99.9
100 - 299.9
300 - 2726.718
Delta watershed and subarea outlines
N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0 - 99.9
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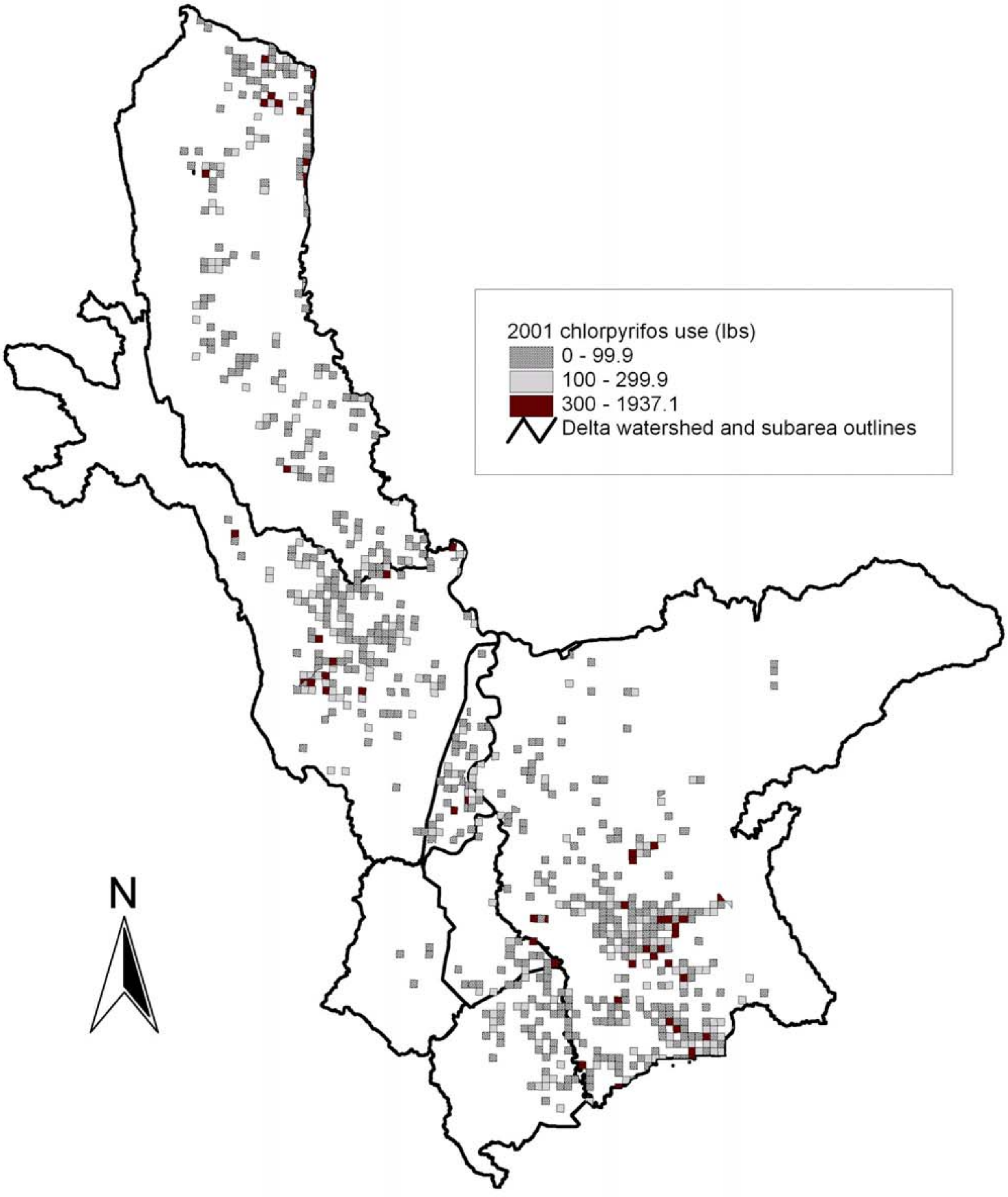
300 - 1628.66
Delta watershed and subarea outlines
N


2001 chlorpyrifos use (lbs)
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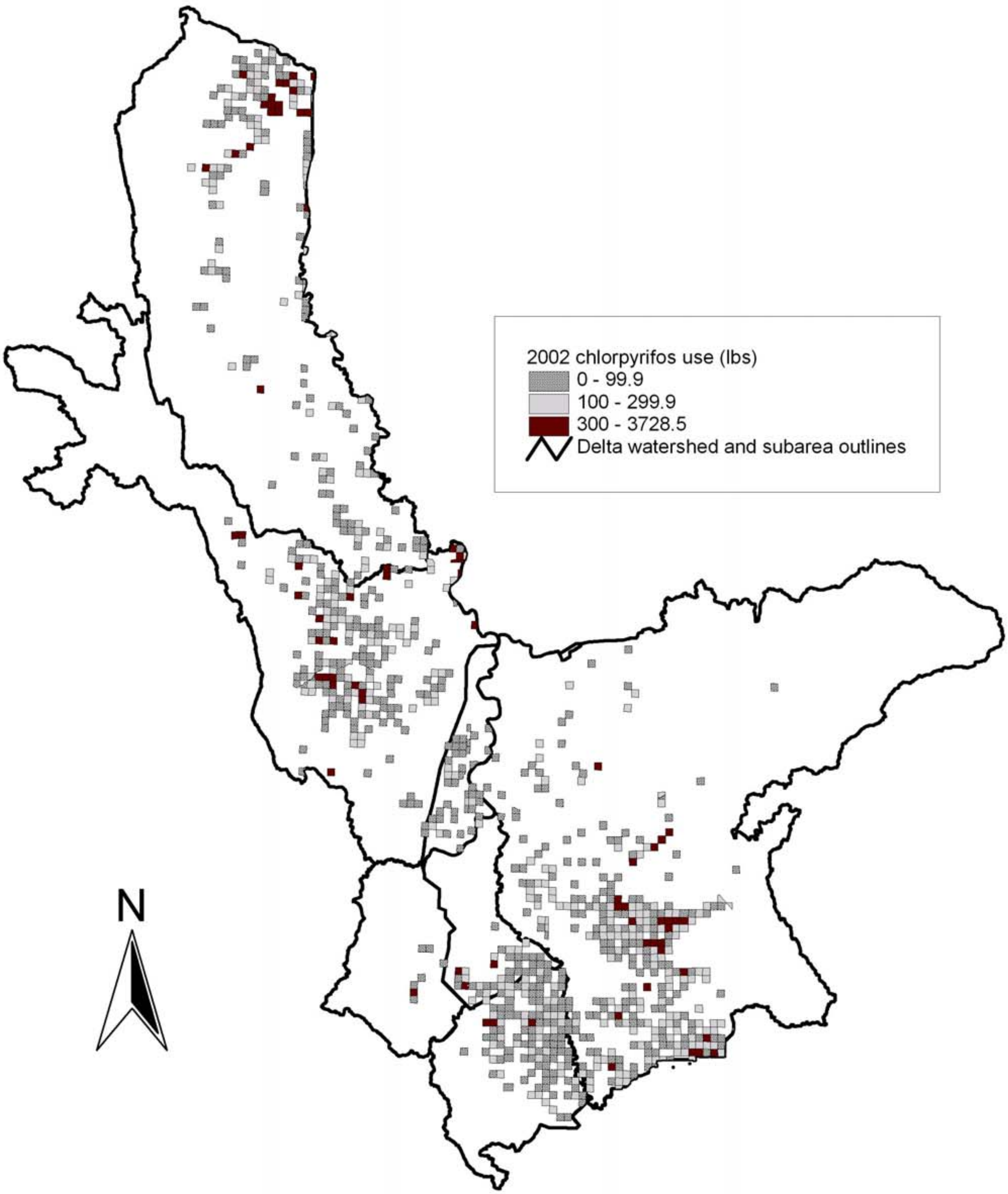
100 - 299.9
300 - 1937.1
Delta watershed and subarea outlines
N


2002 chlorpyrifos use (lbs)
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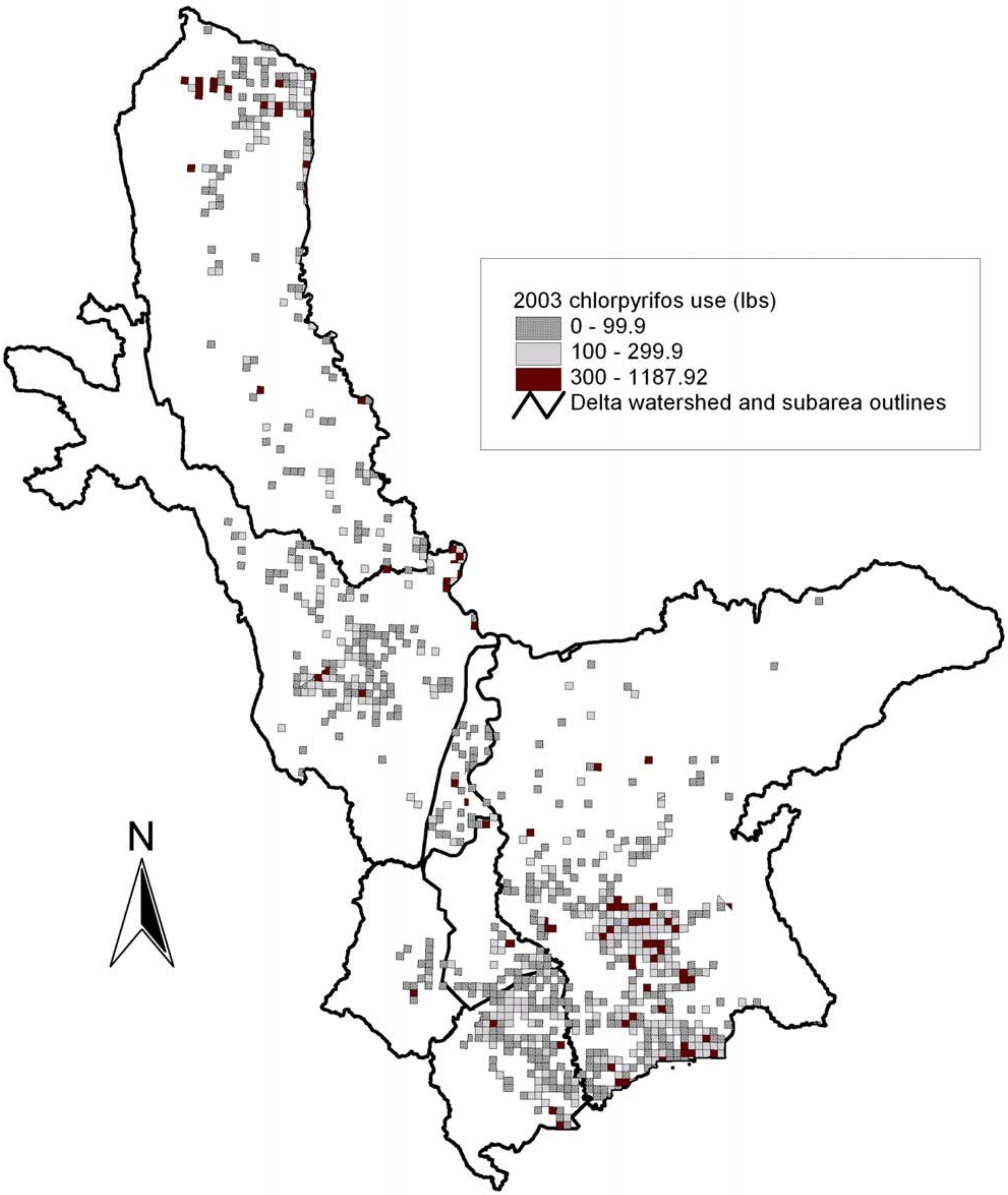
300 - 3728.5
Delta watershed and subarea outlines
N


2003 chlorpyrifos use (lbs)
0 - 99.9
100 - 299.9
300 - 1187.92
Delta watershed and subarea outlines
N